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ALLOCATIVE EFFICIENCY ANALYSIS (HIV) 2015-2030

KARNATAKA & PUNJAB –INDIA

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IN COLLABORATION WITH
NATIONAL AIDS CONTROL ORGANISATION,
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Abbreviations

AIDS	Acquired Immune Deficiency Syndrome
ANC	Antenatal Care
ART	Antiretroviral Therapy
BSS	Behavioural Surveillance Survey
CST	Care, Support and Treatment
CMIS	Computerized Management Information System
FSW	Female Sex Workers
GP	General Population
GoI	Government of India
HIV	Human Immunodeficiency Virus
HRG	High Risk Group
HSS	HIV Sentinel Surveillance
HTC	HIV Testing and Counselling
IBBS	Integrated Bio Behaviour Survey
IBBA	Integrated Bio Behaviour Assessment
ICTC	Integrated Counselling and Testing Centre
IEC	Information, Education and Communication
KP	Key Population
LWS	Link Worker Scheme
M & E	Monitoring & Evaluation
MoHFW	Ministry of Health and Family Welfare
MSM	Men who have Sex with Men
NACO	National AIDS Control Organisation
NACP	National AIDS Control Program
NGO	Non-Governmental Organizations
NIMS	National Institute of Medical Statistics
ORW	Out Reach Worker
PE	Peer Educator
PWID	People Who Inject Drugs
PHFI	Public Health Foundation of India
PLHIV	People Living with HIV
PPTCT	Prevention of Parent to Child Transmission
SACS	State AIDS Control Society
SIMS	Strategic Information Management System
TB	Tuberculosis
TI	Targeted Intervention
TSG	Technical Support Group (condom)
TSU	Technical Support Unit
UNSW	University of New South Wales
WB	World Bank

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Executive summary

The HIV epidemic in India is described as a concentrated epidemic. However, the program response is faced with two critical challenges: (i) the decline in the epidemic is not uniform across the country as there are signs of increasing new infections among some population groups in some states, and (ii) resource constraints.

In order to improve understanding of these factors with the backdrop of targets set by NACP-IV and SDG, it was important for policy makers and managers to understand interactions of the challenges with the future of program progress and how the limited resources can be reallocated, based on evidence, to provide the best results. Thus two states of India, with diverse HIV epidemics, were chosen for this pilot analysis. Karnataka is known to have an early sexually driven epidemic which is currently showing a declining trend, whereas Punjab is known to be undergoing an injecting drug use driven epidemic at present.

The objective of the analysis was to determine (i) the optimal programmatic funding allocations to minimise new HIV infections and deaths and (ii) the optimal programmatic funding allocations to achieve specific impact and coverage targets at the lowest costs in the medium-term. In-line with National Program monitoring framework, the current NACP targets till year 2017 in the program created with year 2007 as base line. In addition, for SDG target of year 2030 analysis the baseline is created for the year 2010.

Guided by the team of contributors led by NACO, multiple scenarios and key questions were decided for the analysis. The key results are given below against each scenarios/key questions

1. How close are we to National Strategic Plan (NSP) targets under current funding/expenditure (expenditure of 2014-15 was considered as current expenditure)?

   In Karnataka, under the current funding/expenditure scenario, the program is expected to achieve a 67% reduction in the in the number of new infections and 70% reduction in number of deaths compared to 2007 levels by the year 2017. By the year 2030, it is estimated that a 74% reduction can be achieved in the number of new infections and 78% reduction in deaths compared to 2010 levels. While in Punjab, it is expected that the state will achieve a 36% reduction in the number of new infections and 37% reduction in number of deaths compared to 2007 levels by year 2017. If current spending is maintained by the year 2030, a 21% **increase** is expected in the number of new infections and 26% **increase** in deaths compared to 2010 levels.

   Optimization of program priorities would result in the following:

   In Karnataka:

i. By the year 2017, it is estimated that the program can achieve a 67% reduction in the number of new infections and 70% reduction in number of deaths compared to 2007 levels
ii. By the year 2030, it is estimated that a 74% reduction can be achieved in the number of new infections and 78% reduction in deaths compared to 2010 levels

b. In Punjab:
i. By the year 2017, a 36% reduction in the number of new infections and 37% reduction in number of deaths can be achieved compared to 2007 levels
ii. By the year 2030, if current spending is maintained a 21% **increase** is expected in the number of new infections and 26% **increase** in deaths compared to 2010 levels

2. What will happen with optimal allocation of current expenditure?
a. In Karnataka, optimization of the current budget suggests that the greatest impact can be achieved by increasing funding to ART by 1.3 times current levels, while sex worker programs, Opiate Substitute Therapy (OST), other condom distribution and Prevention of Mother to Child Transmission (PMTCT) should all maintain similar levels of funding. These identified priority programs should be complemented by other programs only if additional resources can be made available.
i. By the year 2017, there will be an 84% reduction in the number of new infections and 90% reduction in number of deaths compared with 2007 levels
ii. This will result in around 40,000 (~30% more of number of people on ART from year 2014-15) more people annually on ART, will avert around 11,500 new infections and 27,000 deaths between 2016 to 2030.
iii. By the year 2030, there will be 82% reduction in the number of new infections and 88% reduction in deaths compared to 2010 levels
iv. The cost of avoiding a new infection from year 2016 to year 2030 will be approximately INR-2,150,791 and averting a death is INR-917,078 for the same period.

b. In Punjab optimization of program priorities without increase in spending shows that the greatest impact can be achieved by increasing funding to ART by 1.6 times current levels, OST should increase 1.2 times current levels and other PWID programs should be maintained as priority. To support the increase in ART programs, it is also important to increase HTC programs (by up to 50%). These identified priority programs should be the focus of the HIV response and only complemented by other programs if substantial additional resources are made available. Optimization of program priorities would result in the following:

i. By the year 2017, there will be a 60% reduction in the number of new infections and a 67% reduction in number of deaths compared to 2007 levels
ii. ~6,000 additional people to be put on ART (~40% more of number of people on ART from year 2014-15) averting around 13,000 new infections and 7,400 deaths between 2016-2030
iii. By the year 2030, there will be a 42% reduction in the number of new infections and a 46% reduction in deaths compared to 2010 levels
iv. The cost of avoiding a new infection from year 2016 to year 2030 will be approximately INR-525,844 and averting a death is INR-923,850 for the same period.

3. What could be achieved if budgets are scaled up by 25% and allocated optimally?
    a. In Karnataka, optimization of program priorities with 25% increase in spending shows that the greatest impact can be achieved by increasing funding to ART, OST and HTC by 1.3 times current levels, while sex worker programs, MSM, PWID and PMTCT should all maintain similar levels of funding and STI and Condom program for general population should be defunded. The identified priority programs should be complemented by other programs only if additional resources can be made available. Optimization of program priorities would result in the following:

        i. By the year 2017, it is possible to achieve a 85% reduction in the number of new infections and a 91% reduction in number of deaths compared to 2007 levels
        ii. This will also result in 42,000 additional people on treatment and is estimated to avert around 13,000 new infections and 30,000 deaths, through the period 2016-2030.
        iii. By 2030, an estimated 86% reduction in the number of new infections and a 92% reduction in deaths can be achieved compared to 2010 levels
        iv. The cost of avoiding a new infection from year 2016 to year 2030 will be approximately INR-2,242,015 and averting a death is INR-971,540 for the same period.

    b. In Punjab, optimization of program priorities with 25% increase in spending shows that the greatest impact can be achieved by increasing funding to PWID program by 2 times, HTC by 1.7 times, ART by 1.6 times, OST by 1.6 times, Sex worker program by 1.2 times and MSM program by 1.2 times of current levels. These identified priority programs should be complemented by other programs only if additional resources can be made available. Optimization of program priorities would result in the following:

i. By the year 2017, it is possible to achieve a 61% reduction in the number of new infections and 67% reduction in number of deaths compared with 2007 levels.
ii. This will also result in 6,000 more people on treatment and is estimated to avert around 13,700 new infections and 7,500 deaths between 2016 - 2030.
iii. By the year 2030, a 45% reduction in the number of new infections and a 48% reduction in deaths can be achieved compared with 2010 levels.
iv. The cost of avoiding a new infection from year 2016 to year 2030 will be approximately INR-579,513 and averting a death is INR-1,057,920 for the same period.

4. What could be achieved if budgets are scaled up by 50% and allocated optimally?
    a. In Karnataka, optimization of program priorities with 50% increase in spending shows that the greatest impact can be achieved by increasing funding to HTC by 3.3 times, ART by 1.4 times, OST by 1.3 times of current levels, while sex worker programs, MSM, PWID and PMTCT should all maintain similar levels of funding, STI and Condom program for general population should be defunded. These identified priority programs should be complemented by other programs only if additional resources can be made available. Scaling of budgets up by 50% with optimal allocation are expected to result in the following:
        i. By the year 2017, it is possible to achieve an 86% reduction in the number of new infections and 92% reduction in number of deaths compared to 2007 levels
        ii. This will also result in around 45,000 more people annually on ART, and is estimated to avert around 15,000 new infections and 35,000 deaths, from 2016 to 2030.
        iii. By the year 2030, it is possible to achieve an 89% reduction in the number of new infections and 95% reduction in deaths compared to 2010 levels
        iv. The cost of avoiding a new infection from year 2016 to year 2030 will be approximately INR-2,237,219 and averting a death is INR-985,808 for the same period.

    b. Punjab: Optimization of program priorities with 50% increase in spending shows that the greatest impact can be achieved by increasing funding to PWID program by 3.3 times, ART by 1.8 times, OST by 1.8 times and HTC by 1.7 times, Sex worker program by 1.4 times, MSM program by 1.3 times, of current levels. These identified priority programs should be complemented by other programs only if additional resources can be made available. Scaling of budgets up by 50% with optimal allocation are expected to result in the following:

i. By the year 2017, it is possible to achieve a 62% reduction in the number of new infections and 67% reduction in number of deaths compared to 2007 levels
ii. This will also result 6,000 more people annually on ART, and is estimated to avert around 13,800 new infections and 7,500 deaths, from 2016 to 2030.
iii. By the year 2030, it is possible to achieve a 46% reduction in the number of new infections and 48% reduction in deaths compared to 2010 levels
iv. The cost of avoiding a new infection from year 2016 to year 2030 will be approximately INR-654,515 and averting a death is INR-1,204,308 for the same period.

5. What benefits can be achieved via implementation efficiency gains up to 20%?
    a. In Karnataka optimization with 20% efficiency gain in fixed cost spending shows that condom and STI programs need to be defunded. TI program and OST funding will reduce by 75%.While spending on HIV testing will reduce by 50%, the ART program spending will have to increase by 1.3 times of current level of expenditure.Implementation efficiency gains up to 20% are expected to yield the following:
        i. By the year 2017, an 83% reduction in the number of new infections and 91% reduction in number of deaths is possible compared to 2007 levels
        ii. This will result in 41,000 more people annually on ART, and is estimated to avert around 12,000 new infections and 28,000 deaths, from 2016 to 2030
        iii. By the year 2030, an83% reduction in the number of new infections and 89% reduction in deaths is possible compared to 2010 levels
        iv. The cost of avoiding a new infection from year 2016 to year 2030 will be approximately INR-2,061,165 and averting a death is INR-883,361 for the same period
    b. In Punjab, optimization with 20% efficiency gain in fixed cost spending shows that while the condom and STI program will be defunded, spending will increase in PWID program by 1.8 times, OST program by 1.6 times FSW and MSM program by 1.2 times of current level of expenditure. HIV testing program will be defunded by 80%. Implementation efficiency gains up to 20% are expected to yield the following:
        i. By 2017, a61% reduction in the number of new infections and 67% reduction in number of deaths is possible compared to 2007 levels
        ii. This will result in putting around 6,000 more people annually on ART, and is estimated to avert around 13,300 new infections and 7,300 deaths from 2016 to 2030.
        iii. By the year 2030, a 43% reduction in the number of new infections and 45% reduction in deaths is possible compared to 2010 levels

iv. The cost of avoiding a new infection from year 2016 to year 2030 will be approximately INR-514,022 and averting a death is INR-936,055 for the same period

6. Increasing CD4 eligibility criteria from current level of CD4<350 to CD4<500 with optimal allocation of expenditure which is 25% more than the current expenditure:
    a. In Karnataka, increased treatment eligibility of CD4 count from the current level of <350 to <500, with 25% expenditure than 2014-15 financial year expenditure allocated optimally shows that condom and STI programs need to be defunded. While FSW program will increase by 2.8 fold , the ART program spending will have to increase by 10%, OST, MSM and PWID program funding will remain at the current level the spending and that of HIV testing will decrease by 80%. This will result in 72% reduction in new infections and 76% reduction in deaths by 2017 in comparison to respective values in 2007. This is also estimated to yield a 78% reduction in new infections and 83% reduction in deaths by 2030 in comparison to respective values in2010.The change in eligibility criteria with optimal allocation is expected to achieve the following:
        i. 72% reduction in new infections and 76% reduction in deaths by 2017 in comparison to respective values from year 2007.
        ii. 78% reduction in new infections and 83% reduction in deaths by 2030 in comparison to respective values from year 2010

    b. In Punjab, increased treatment eligibility of CD4 count from the current level of <350 to <500, with 25% expenditure than 2014-15 financial year expenditure allocated optimally shows that condom, and STI program needs to be defunded. While the ART program spending will have to increase by 60% , HIV testing will increase by 60%, OST program will increase by 30%, FSW, MSM and PWID program funding will remain at the current level of spending. This will result in 60% reduction in new infections and 66% reduction in deaths by 2017 in comparison to respective values in 2007. This is also estimated to yield a 43% reduction in new infections and 47% reduction in deaths by 2030 in comparison to respective values in 2010. The change in eligibility criteria with optimal allocation is expected to achieve the following:

        i. 60% reduction in new infections and 66% reduction in deaths by 2017 in comparison to respective values from year 2007.
        ii. 43% reduction in new infections and 47% reduction in deaths by 2030 in comparison to respective values from year 2010

7. How much funds are required to achieve SDG targets with optimal allocation?

While it is feasible for the state of Karnataka to achieve both the National and SDG goals, by increasing the funding to 1.7 times of current expenditure and through optimal allocation of

the funds, it will not hold the same for the state of Punjab, unless there are more effective interventions. Despite optimal allocation of current funds and even increased allocation to the ART and OST programs, the program in Punjab will not be able to meet the SDG targets. In order to achieve SDG, newer and effective programs need to be put in place in addition to optimal allocation of funds in Punjab.

a. Karnataka:
    i. Increase in funds to ~ 1.7 times of current expenditure and allocating optimally
    ii. OST program spending will be increased by 1.4 times, ART program by 1.4 times and HIV testing by 6 times compared to current levels
    iii. Compared to 2010 values, a 92% reduction in new infections, and reduction in deaths up to 98% by 2030
b. Punjab:
    i. In the state of Punjab high levels of budgetary increase will not achieve desired results of 90% reduction in number of new infections and deaths by 2030 from the baseline value of 2010.
    ii. With 3.6 times increase in expenditure, allocated optimally, can result in 81.8% reduction in new infections and 93% reduction in deaths by year 2030.

Optimal allocation of funds in simple words means reallocation of funds from one budget head to another budget head in the national program, keeping effectiveness of each type of intervention in perspective. This provides guidance on the re allocation of investment in the current program context to achieve greater results with the given financial resources. In addition this also provides the investment road map to reach the national and global targets. This analysis suggests that the current level of funds can be optimally allocated by reducing the management/implementation, condom and STI expenditure while substantially increasing the ART expenditure resulting in bringing more people into the fold of treatment. This is expected to result in bringing down the number of new infections and deaths substantially in Karnataka and to a lesser extent in Punjab. In the long run this will translate to State of Karnataka achieving both the National and SDG goals while in the state of Punjab, unless there are more effective interventions, in spite of optimal allocation of current funds and even increased allocation to the ART and OST programs, the program will not be able to meet the SDG targets

In principle, key results indicate towards greater emphasis on investment on prevention tools among those who are identified as HIV positive and an effort towards finding those who are not. The framework of OPTIMA software provides the scope to examine the effect of ART as prevention tool among PLHIV. OPTIMA does model for condom use among PLHIV, however it does not allow for different behaviour condom behaviour post diagnosis. Though prima-facie, there is information available on the importance of condom in preventing transmission of HIV from PLHIV, with additional preventive effect when used along with ART. Thus, condom,

as a general population intervention, may be defunded to a large extent and re packed as an essential intervention along with ART, for HIV prevention among PLHIV.

Given the diversity of the HIV epidemic within the country, the variations in resource needs, with differences in allocation of funds, it may not be possible to apply the findings from two states to the entire country. Thus, it may be considered to have expand the scope of the study to cover all the states of India.As the national AIDS control program is a centrally sponsored scheme, the consideration of optimal reallocation of funds at the state level would be led by the national program.

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Introduction

HIV Epidemiology

The HIV epidemic response in India is in its third decade.[1][2] The country is considered to have a concentrated epidemic with various high risk group (HRG) populations driving the epidemic, this includes Men Who have sex with Men, Female sex workers, Injecting drug users etc. The adult HIV prevalence at national level has continued its steady decline from an estimated level of 0.38% in 2001 to 0.26% in 2015.[3]However there are state level variations in both the level and trend of epidemic. According to care (ANC) surveillance report 2012-13 records, the highest prevalence is in Nagaland (0.88%) followed by Mizoram (0.68%), Manipur (0.64%), Andhra Pradesh (0.59%) and Karnataka (0.53%). Also, states like Chhattisgarh (0.51%), Gujarat (0.50%), Maharashtra (0.40%), Delhi (0.40%) and Punjab (0.37%) recorded HIV prevalence higher than the national average.[4]

National AIDS Control Program in India

India's initial response to the HIV/AIDS challenge was in the form of setting up an AIDS Task Force by the Indian Council of Medical Research (ICMR) and a National AIDS Committee (NAC) headed by the Secretary, Ministry of Health. In 1990, a Medium Term Plan (MTP, 1990-1992) was launched in four states, namely, Tamil Nadu, Maharashtra, West Bengal and Manipur and four metropolitan cities, namely, Chennai, Kolkata, Mumbai and Delhi. The MTP facilitated targeted IEC campaigns, establishment of surveillance systems and safe blood supply. The National AIDS response in the country has consistently made progress from its launching in 1992 as Phase-I(1992-1999).With the aim of strengthening the management capacity, a National AIDS Control Board (NACB) was constituted and an autonomous National AIDS Control Organization (NACO) was set up for implementation[5]with focus on awareness generation, blood safety programs and programs for high risk populations. The second National AIDS Control Program (NACP-II) was implemented during 1999-2006. The focus shifted from raising awareness to changing behaviour, decentralization of program implementation at the state level, greater involvement of Non Governmental Organisations (NGOs) and introduction of antiretroviral treatment (ART).

India implemented the third phase of the National AIDS Control Program during 2007-2012 with the goal of "Halting and Reversing the Epidemic" by scaling up prevention efforts among High Risk Groups (HRG) and the general population and integrating with Care, Support & Treatment Services (CST). Thus, prevention and CST formed the two key pillars of all AIDS control efforts in India. Strategic information management and institutional strengthening activities provided the required technical, managerial and administrative support for implementing the core activities under NACP-III at national, state and district levels. NACP III focused on a decentralized response and an increasing engagement of NGOs and networks of people living with HIV/AIDS.[6] India is currently implementing the National AIDS Control Program Phase IV (2012-17). Consolidating the gains made till now, the fourth phase of National AIDS Control Program (NACP-IV) aims to "accelerate the process of epidemic reversal" and further strengthen the epidemic response in India.[2]

Human development Health and Financing

India is a lower middle income country, with a population of almost 1.3 billion.[7]While the poverty headcount ratio (using national poverty lines) has decreased from 45.3% (1993) to 21.9% (2011), life expectancy has increased from 61 years (1996) to 68 (2014) and the Gross National Income has increased from $410 to $1,570, in the same time period.[7] Though India has made considerable strides in macro development indicators, there are substantial public health challenges and resource constraints which influence India's response to the HIV epidemic.

Human development

The Human Development Index (HDI) value for India was 0.609 (2014), situating India in the medium human development category, ranking 130 out of 188 countries and territories. Between 1980 and 2014, India's HDI value increased from 0.362 to 0.609, an increase of 68.1 percent or an average annual increase of about 1.54 percent.[8] However, the composite index belies large variations in underlying dimensions of life expectancy at birth, educational attainment, and per capita incomes, both within and across Indian states. For example, the state of Assam had a life expectancy of 61.9 years, nearly 12.3 years lower than that of Kerala at 74.2 years, in 2011.[9] These dimensions also vary by socio-cultural factors such as caste and gender.

Burden of Disease

The varying course of the demographic transition in India has resulted in an epidemiological transition, and consequently changes in the burden of disease in terms of morbidity and mortality. There are regional variations in the transition, with southern states progressing further along than northern states.[10] The top ten causes of death in 2010 included pre-term birth complications, lower respiratory infections, diarrheal diseases, ischemic heart disease, COPD (Chronic Obstructive Pulmonary Disease) neonatal sepsis, tuberculosis, self-harm, road injury and stroke (in order of Years of Life Lost [YLL]).[11] HIV climbed from 78th rank in 1990 while 12th rank in 2010 contributing to 2.3% of total YLL. Non-communicable diseases have registered increases in the share of the morbidity burden, especially ischemic heart disease, COPD, stroke, congenital anomalies and diabetes. However, there has been a decline in under-five mortality, maternal mortality, and mortality due to TB and malaria.[12]

Health Financing in India

Total health spending in India is around 4% of GDP, of which nearly 69% is borne by households as out-of-pocket expenditure.[7] Government funding constitutes almost a fourth of all health expenditure, and nearly two-thirds of this is contributed by the subnational, or state level governments. In monetary terms, for the most recent year for which statistics are available, state's contribution to Total Health Expenditure (THE) is about Rs. 650 per capita per year. Per capita expenditure on health has increased from $19 (2000) to around $57 (2010), however most of it has been through private out-of-pocket (OOP) expenditure.

The coverage of compulsory pre-payment and risk-poling mechanisms is low, with enrolment at around 10%.[13] Recently, efforts have been made to include the poor and informal workers under state and nationally-driven social health insurance schemes which provide limited secondary and tertiary hospitalisation services, such as the *Rashtriya Swasthya Bima Yojana* (RSBY), yet coverage gaps remain.[14]Inadequate financial protection for health has meant that the majority of OOP expenditures have historically been incurred in the private sector, compounded by the limited availability and variable quality of care in the government sector.[15][16]Many households are forced into poverty due to health expenditures; it has been estimated that in 2004 more than ten million Indian households fell below the poverty line due to catastrophic healthcare spending.[17]

The power to implement health programs and interventions primarily rests with Indian states, with policy directives provided by the central (federal) government. Government disbursements for health are made according to priorities set in the Five Year Plans (PYPs), which are formulated by National Institution for Transforming India (NITI) Aayog (formerly known as the Planning Commission). The 12th Five Year Plan (2012-2017) has allocated funds of 1.5 per cent of the GDP, while at the same time notionally targeting an increase of public health expenditure to 2.5 per cent of the GDP. Central policy directives serve as a blueprint for the planning and implementation of national health programs, such as the NACP.

Figure2.1: Health financing profile of India, 2014[1]:

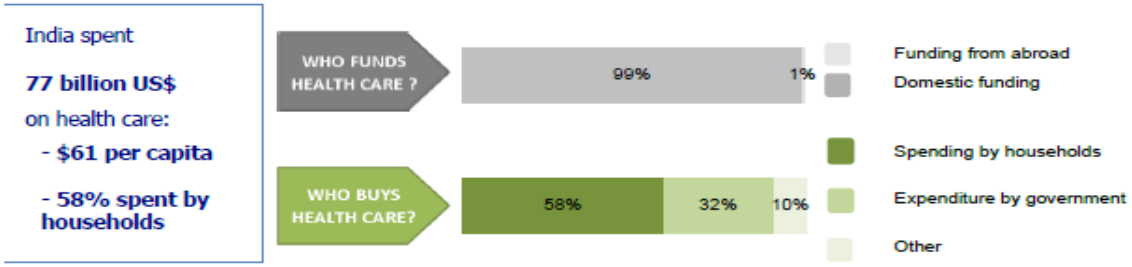

Figure2.2: Trend of total, government and household expenditure on health, India[2]

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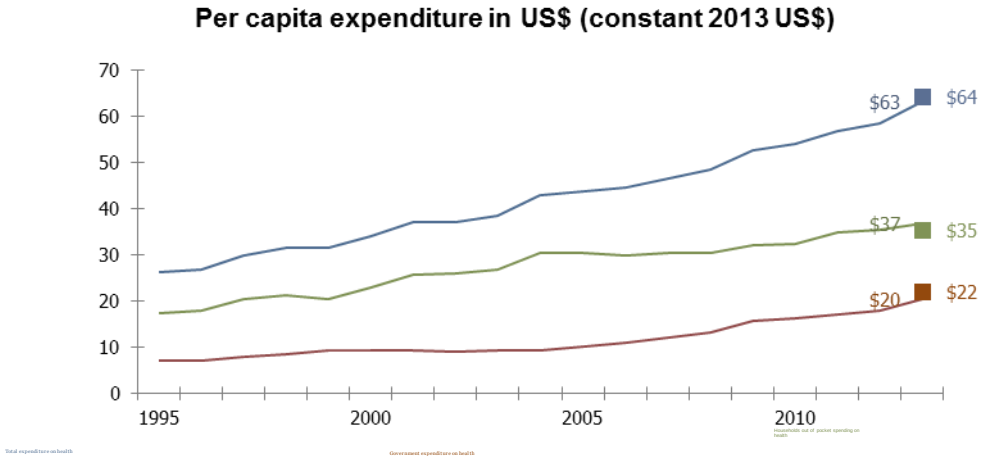
[1] source: http://apps.who.int/nha/database/Country_Profile/Index/en

[2] Source: Health System Financing profile by country: India
http://apps.who.int/nha/database/Country_Profile/Index/en



HIV/AIDS Financing

The NACP-III (2007-2012) assumed an investment of Rs. 11,585 crore to implement a wide range of interventions, of which Rs. 8,023 crore was to be provided through the budget, with the balance being extra budgetary funding. The resource envelope identified for NACP-III included external funding from Development Partners (both budgetary as well as extra budgetary support), bilateral and multilateral agencies and UN agencies. These extra-budgetary resources supplemented the domestic contribution by Government of India. During NACP-III period, an expenditure of Rs. 6,237.48 crore was incurred through budgetary sources. The total approved budget for NACP-IV is Rs.13,415 crore which comprises Government Budgetary Support, Externally Aided Budgetary Support from the World Bank (WB) and Global Fund, and Extra Budgetary Support from other Development Partners.[3]It is estimated that 63% of the funds will be generated through budgetary sources of Government, 14% from the Global Fund, 10% from the WB, and 13% through extra budgetary resource from other development partners. The component-wise breakdown of the NACP-IV budget indicates that 63% of the overall estimated budget is allocated for prevention services and 30% towards care, support and treatment services. The balance of 7% is bifurcated among the components of Institutional Strengthening and Project Management (4%) and the Strategic Information Management Systems (SIMS, 3%).[2]

Allocative Efficiency Analysis in HIV and Health

As the HIV epidemic in the country continues to be heterogeneous, especially in terms of its geographical spread, appropriate program response based on evidence is required for successful reversal of the HIV epidemic in the country, particularly in the context of competing and limited resources. More so, the importance of resources and resource allocation to various components/ strategies in the context of the global call for "Getting to Zero"(18), and meeting targets aimed by Sustainable Development Goals(19) requires the need to re-look at the best mix of options to improve outcomes in terms of reduction of new infections and deaths.

There has been a significant shift in the funding pattern in recent years with respect to HIV and public health. Depleting donor funding due to reprioritization to other diseases and public health programs is of concern. Government of India is making an effort to increase the

[3] NACO _ Annual Report 2013-14

domestic funding support for the HIV response. Keeping the new knowledge made available for effective program implementation[20][21][22][23], the HIV allocative efficiency study primarily entails evaluating the response to the HIV/AIDS epidemic for its value for money on an investment vs. achievement scale. The project envisages studying the current allocation of available resources and suggesting how available funding can be channelled and reallocated through appropriate policy level changes to achieve higher efficiency in HIV prevention and treatment programs. The concept of allocative efficiency refers to the maximization of health outcomes with the least costly mix of health interventions.

Optima Model

Optima is an application software to support prioritization of HIV investment by determining the optimal allocation of resources and coverage levels across programs in specific HIV epidemic settings. Optima can be used to conduct an integrated analysis of epidemic, program and cost data to determine the optimal distribution of investment to help HIV and health decision makers and planners make informed decisions. Optima was developed by the University of New South Wales (UNSW), revised and updated in partnership with the World Bank (WB), and has been used in over 50 countries.

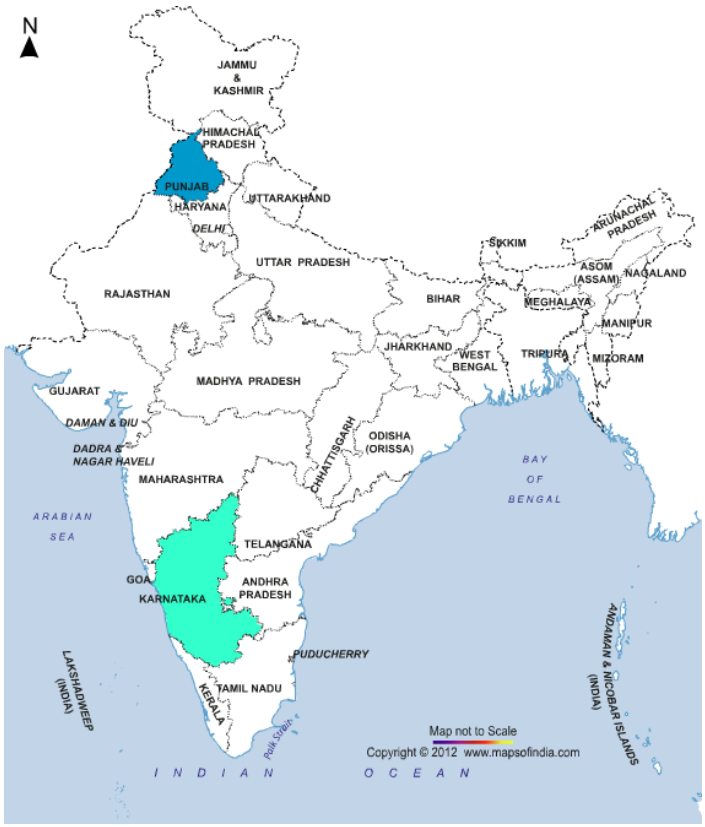
Continuing its efforts in India for combating the HIV epidemic, the WB engaged with the Public Health Foundation of India (PHFI) as a technical partner to execute the HIV allocative efficiency study. The project collaborated with National AIDS Control Organisation (NACO), National Institute of Medical Statistics (NIMS), and UNSW/WB for technical support.

Rationale for choosing the two states

The states of Karnataka and Punjab were identified as pilot states for using the Optima software. The states were selected for several reasons: they had prevalence above the national average; were geographically located in the north and south of the country; and the epidemic in Karnataka was considered as matured with a declining epidemic, driven mostly by sexual networks, while the Punjab epidemic is considered as emerging with increasing trends and driven by injecting drug use. However, the common features that allowed comparison were having better MIS and good quality longitudinal data sets available.

Figure 2.3: Selected states in India[4]

[4]**Source:** www.mapsofindia.com



Karnataka

Karnataka is a state in the southern part of India. It is bordered by the Arabian Sea to the west, Goa to the northwest, Maharashtra to the north, Andhra Pradesh and Telangana to the east, Tamil Nadu to the southeast, and Kerala to the southwest. The state covers an area of 191,976 km², or 5.83% of the total geographical area of India. It is the eighth largest Indian state by area and the ninth largest by population. Karnataka, with 30 districts and a population of 61 million,[24] is one of four large states in South India facing a relatively advanced HIV epidemic. According to national estimates in 2015, Karnataka state had an HIV prevalence of 0.45% among adult (15-49 years) with 210,000peopleliving with HIV.[25] The major route of transmission is heterosexual sex.

Punjab

Punjab state is located in the north-western part of India. It is bounded by the Indian states of Jammu and Kashmir to the north, Himachal Pradesh to the northeast, Haryana to the south and southeast, and Rajasthan to the southwest, and by the country of Pakistan to the west. The state of Punjab has an area of 50,362 sq. km and has a population of 27 million as per the 2011 census.[24]Estimated adult HIV prevalence in Punjab is 0.19 % with nearly 30,000 people living with HIV in the year 2015.[25]Though heterosexual transmission was known to be key route of HIV transmission earlier,[26]injecting drug users are recognised as one of the main drivers of the Punjab epidemic at present.[27]

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Policy targets for allocative efficiency

A series of meetings and discussions were held with National AIDS Control Organisation (NACO), National Institute of Medical Statistics (NIMS), the World Bank (WB) and other key stakeholders to arrive at the critical policy questions for the exercise. With over 20years of implementation of the program, NACO's interest lay in understanding the future needs of the program in-terms of direction of the epidemic and best utilisation of committed resources to meet the national goals and global commitments. The details of the policy questions for this analysis are described in Table3.1.

Table3.1: Policy Questions

Policy questions	Optimization and scenario settings
• **How close are we to National Strategic Plan (NSP) targets under current funding?** Over the NSP period, how close will each state get to NSP HIV impact targets: With the current volume of funding, allocated according to current expenditure? With the current volume of funding, allocated optimally?	Define objectives: ● 1. Baseline 2007 ● 2. Midline 2017(50% reduction is number of new infections and 50% reduction in death from baseline) ● 3. End line(2030, 90% reduction in new adult infections, including among key populations and 90% reduction in AIDS-related deaths from 2010 levels) Constraints: ● No one who initiates ART or OST is to stop receiving ART, except through natural attrition ● ART coverage capped at ~60% of all PLHIV to reflect eligibility criteria. ● Current treatment eligibility criterion:CD4 count 350. One of the optimization scenarios should take the CD4 count as <500, which will be rolled out in India from1st April 2016. The rounded figures for additional numbers of people who will be on ART in the year 2016-17, will be 12500 for Karnataka and 3400 for Punjab. • For each run, compare projected outcomes: • With the current volume of funding, allocated according to current expenditure ('baseline'); • With the current volume of funding, allocated optimally.
• **What could be achieved if budgets are scaled up?** What is the epidemiological impact if available resources are scaled up by 25-50% of current levels?	Repeat analysis 1with scaled budgets at 1.25, 1.5 times 2015-16 budget levels Constraints: • No one who initiates ART or OST is to stop receiving treatment, except through natural attrition • Current treatment eligibility criteria: CD4count 350. One of the optimization scenarios should take the CD4 count as <500, which will be rolled out in India from 1st April 2016. The rounded figures for additional number people who will be on ART in the year 2016-17, will be 12500 for Karnataka and 3400 for Punjab. • KP programs cannot be scaled down more than by 25% of their most recently funded levels

• **How much funding is required to achieve the NSP targets?** Over the NSP period, according to current program implementation practices and costs: How much total funding is required to meet the NSP targets? How is this funding optimally allocated between programs?	Define objectives: ● Minimize money: 1. Baseline 2007, 2. Midline 2017(50% reduction in number of new infections and 50% reduction in deaths from baseline), 3. End line(2030, 90% reduction in new adult infections, including among key populations and 90% reduction in AIDS-related death from 2010 levels) Constraints: ● As above in analysis 1. Additional constraints/scenarios: • As above in analysis 1. Optional. For each run, compare projected outcomes: • With the current volume of funding, allocated according to current expenditure ('baseline'); • With the minimum volume of funding required to achieve targets, allocated optimally.
• **What benefits can be achieved via implementation efficiency gains?** How do results of analyses 1 and 2 above change if plausibly identified implementation efficiency gains are incorporated into the analysis?	Country team to identify plausible efficiency gains. Re-run analysis 1 after making the following adjustments: • For fixed-cost programs: a twenty percentage reduction in fixed program expenditure.
• **What have been the impacts of past program implementation?** Retrospectively, how would have each state's HIV epidemics changed had investment not occurred in programs for key populations?	Scenario analysis: • Scenario starts in 2007 and ends in 2017. • Parameter values at start: background/values under zero program funding. • Parameter values at end: current values. • Program impacts of FSW, PWID and MSM can be isolated by specifying separate scenarios for each. • Compare epidemiological outcomes for each scenario with outcomes from the baseline (i.e., 'current spending' optimization).
• **What is the expected future impact of program implementation?** What is the projected trajectory of each state's HIV epidemic if coverage of key population programs were extended to 'the last mile'? What is the estimated cost-effectiveness of this scale up?	Scenario analysis: • Scenario starts in 2007 and ends in 2030. ● Year 2007 is baseline and Year 2017 is end line for NACP-IV. ● Year 2010 is baseline and year 2030 is end line for SDG. ● Midline 2017 (50% reduction is number of new infections and 50% reduction in death from baseline) ● End line(2030, 90% reduction in new adult infections, including among key populations and 90% reduction in AIDS-related deaths from 2010 levels) • Program impacts of FSW, PWID and MSM can be isolated by specifying separate scenarios for each. • Compare epidemiological outcomes for each scenario with outcomes from the baseline (i.e., 'current spending' optimization).

Objectives

Key Objectives

The key objectives for this study were formulated in a consultative process by key stakeholders, including NACO, NIMS, UNSW, Burnet Institute, PHFI, and WB. Taking into account that different optimization objectives would yield different optimal funding allocations, the objectives are intended to determine:

1. optimal programmatic funding allocations to reduce new HIV infections and deaths; and,
2. optimal programmatic funding allocations to achieve specific impact and coverage targets at lowest costs in the medium-term.

Methodology

A dynamic, population-based mathematical model of HIV transmission and disease progression integrated with economic and financial analyses, called Optima, was used to assess HIV investment choices in India.[5] Optima allows allocative efficiency analyses of the HIV epidemic in a country by incorporating contextual country-level information such as HIV programmatic information, and differences in sub-populations such as key population groups like MSM, FSW, and the general population. Optima tracks the progress of sub-population groups across the CD4 continuum (>500, 350–500, 200–350, 50–200, and <50) and different stages of management (undiagnosed, diagnosed, 1stline treatment, treatment failure, and 2ndline treatment). It also accounts for different modes of HIV transmission including sexual, injecting-related and vertical (mother-to-child). This epidemiological model is combined with economic analyses that appraise the cost of delivering services for each type of program, and a mathematical optimization function to determine the optimal resource allocation to best achieve planned objectives. These objectives can include minimizing new infections, minimizing HIV-related deaths, and/or minimizing long-term financial commitments. Optimizations are based on input values comprising calibrations to epidemiological data; assumptions about the costs of program implementation and corresponding coverage levels; and the effects of these programs on clinical, behavioural, and other epidemiological outcomes.[6]

The study comprised the following steps: (i) developing analytical framework; (ii) development of data requirement framework; (iii) data collection; (iv)data validation; (v) calibration of epidemic curves; (vi) adjustment of cost curves; and (vii) analyses (scenario and optimisation analyses). The model parameters used for the India analyses are subsequently discussed.

Analytical Framework

Time frame and Geographical sites

[5] http://optimamodel.com/about.html

[6] A full description of model parameters, prior distributions and their justifications can be found at: http://optimamodel.com/docs/optima-parameter-priors.pdf.

The time-frame for the data analysis was set from 2015-2030. Two states, Punjab and Karnataka, which were very different in-terms of nature of epidemic and geography, were chosen on pilot basis to understand the applicability of OPTIMA in country context. The model was informed by data available up to the time of the analysis including surveys, research publications, and surveillance reports. The following data and the associated years were decided upon to be collated and used after discussions with UNSW/Burnet, NACO and the WB:

1. Population projections from 2005-2020
2. Behaviour and HIV surveillance/survey data from 2005-2015
3. Program coverage data from 2010-2015.

Ethical clearance

Ethics approval for the study was obtained from Institutional Ethics Committee of the Public Health Foundation of India, New Delhi (vide number TRC-IECexemption number: TRC-IEC-277/15). All data used in the study are anonymized and identification of individuals is not possible through it.

Data requirement framework development

All information and detailed calculations are given in the respective ***Annex (1-10).***

Population

The data requirement framework in Optima is dependent on the two key areas of defining population groups and defining programs. As the epidemic is concentrated among adults in the two states, the populations for the analysis were kept as male and female adults in the age group of 15 to 49 years. The population groups included in this analysis were: FSW, MSM, PWID, clients of sex workers, and adult male and female populations.

Programs

The program interventions that were fed into the model include: condom promotion, Sexually Transmitted Infection (STI) management, targeted interventions for sub-population groups (FSW, MSM, IDU), Opioid Substitution Therapy (OST), HIV Counseling and Testing (HTC), Prevention of Mother to Child Transmission (PMTCT) program, Anti-retroviral Therapy Program (ART) and Management.

Cost

Costs used in the economic analyses entail the actual expenditures incurred in the program for each intervention. These include expenditure incurred at the state level and funded by NACO, and those incurred at the national level for services provided at the state level, for example procurement of test kits, ART medicine, etc. These expenditures are incurred centrally at NACO, but are distributed and consumed at the state level. The cost is divided into three parts as per the programmatic guidance (Table5.1).

Table5.1: Cost classification

Optima	**NACO Program**

Variable cost	Kits, Consumables, or reagents, Drugs. Human resource (field workers; personnel at service delivery units) , Training, Set up cost of newly established service delivery centres
Fixed Cost	Infrastructure, maintenance of old/ existing centres. All the fixed costs associated with treatment programs are placed under this item.
Management cost	Institutional Strengthening, Technical Support Unit, State Training and Resource Centre. Monitoring and Evaluation, Joint Appraisal Team. Management, monitoring and evaluation: for any management costs. This included management cost for TI, ICTC ART etc.

Data collection

The study involved the use of existing/secondary data which is either publicly available or is routinely collected by the National AIDS Control Program. The study used secondary data on several parameters on the 'Input' front, including donor investment, government investment. The data pertaining to various program components and services in terms of program costs, coverage, size estimates were also collected. For epidemiological inputs, wherever program data was unavailable, data from surveillance reports and special evaluation studies was used.

Sources of data required for the study

Based on the discussions held with NACO, NIMS, WB and UNSW, a mapping of key data required and its sources was done. Preference was given to program data because of the robustness of the data collection system and availability of information over period of time. Wherever program data were unavailable, data from HIV Sentinel Surveillance, Integrated Biological and Behavioural Surveillance (IBBS) Survey, BSS, National Family Health Surveys 1-3 (NFHS) and Integrated Biological Behaviour Assessment (IBBA) was used. The list of data used in the project and their sources is given in Annex 1-10.

Data validation

The process of data validation included content analysis of data with respect to data source, process of data collection, and understanding the limitations of each data source in terms of validity and generalisability. The validation process included inputs from NACO divisions, including program and finance. Feedback from UNSW on the quality checks were obtained in parallel and incorporated into the analyses.

Data Matrix (assumptions and validation)

The data matrix describes the variables, assumptions and validations for the population calculations, behaviour parameters, program coverage and cost calculations. The same process was undertaken for both states with a few variations in the case of some variables which have been noted.

Exclusion Criteria

It was agreed upon to exclude certain interventions such as for migrants, and those for which costs and impacts are difficult to quantify, such as IEC programs. This also includes

interventions carried out independently at state level and not funded through the public health system.

Calibration

Optima version 1.0was used for the analysis. The epidemic curves generated by the software were manually calibrated using standard guidelines given below:

- Level of epidemic:
  - For GP – NFHS-3 (year 2005-6) figures act as a guide, NFHS- 4 data on HIV prevalence was not available at the time of the study.
  - For HRG– IBBS (year 2014-15) levels act as a guide.
  - For client–the level is always lower than the FSW level for corresponding years as per IBBA other similar studies.
- Trend of epidemic for a general population is based on:

i. HIV sentinel surveillance
ii. Program experience

- Other key factors taken into consideration:
  - Prevalence, new infections and deaths for male are higher than for female

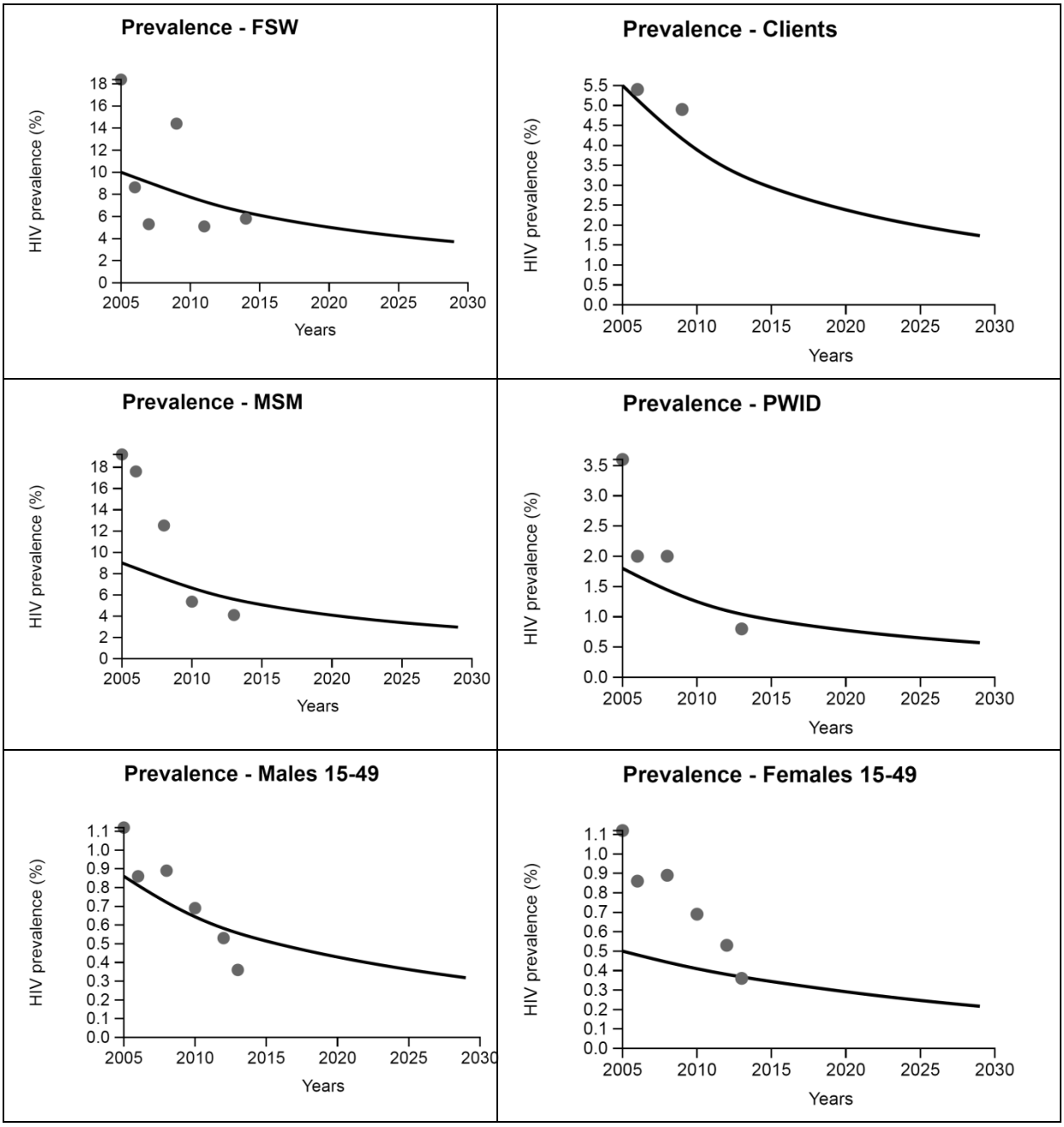
The detailed parameter values are given for each state in Annex-11.

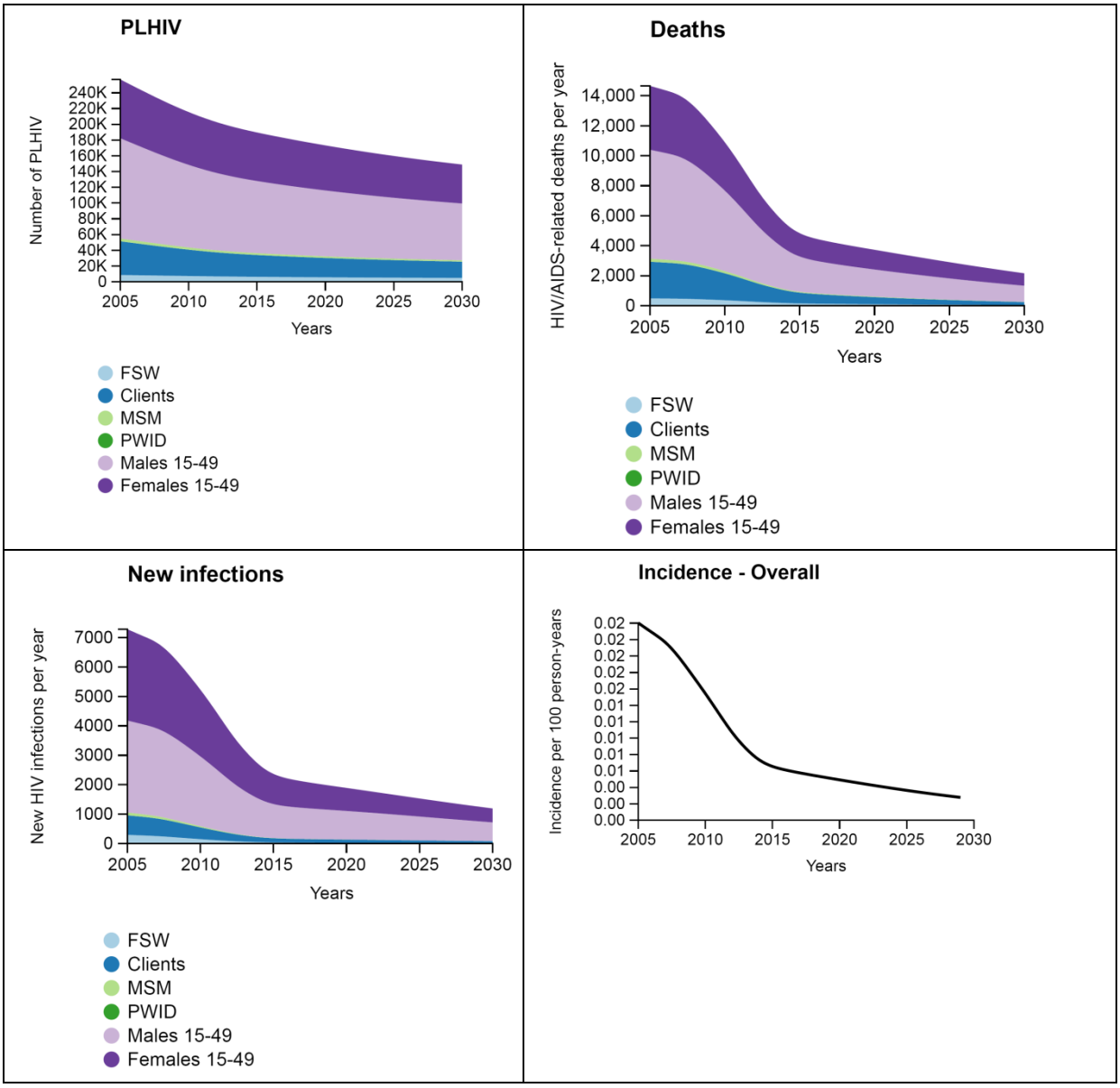
Epidemic curves after calibration

Karnataka

Karnataka is considered to have one of the more mature heterosexual epidemics in India. The epidemic initiated during the late 1980s, and has reached a high prevalence in the general population. The Karnataka epidemic has typically been driven by commercial sex work and heterosexual transmission. FSW have shown very high HIV prevalence levels during the early part of the epidemic, and have been the focus of all prevention interventions in the state for the last two decades. Targeted Interventions (TI) focusing on reduction of HIV transmission among FSW and clients through a strong condom promotion component have been the mainstay of HIV prevention efforts in the state. In addition to the condom program, strong outreach through PE/ORW, biannual HIV testing and STI testing and treatment, BCC, community engagement and mobilization were other key components of the package of services provided to the FSWs. These have been scaled up to saturate the FSW population in the state with around 80% coverage, with a geographical reach of almost every block (sub-district administrative unit) of the state. The state has also seen unprecedented community action through the formation of Community Based Organisations (CBOs), empowerment of community groups through advocacy, training and capacity building and creation of an enabling environment through active engagement of various stakeholders. All these have led to successful declines in the HIV prevalence among FSW from over 15% peak prevalence before 2000 to levels as low as 5-6% in recent years.[27]

Figure-6.1: Calibrated Epidemic Curves – Karnataka


Prevalence - FSW
HIV prevalence (%)
Years
Prevalence - Clients
HIV prevalence (%)
Years
Prevalence - MSM
HIV prevalence (%)
Years
Prevalence - PWID
HIV prevalence (%)
Years
Prevalence - Males 15-49
HIV prevalence (%)
Years
Prevalence - Females 15-49
HIV prevalence (%)
Years



This declining trend of HIV prevalence among FSW has also led to declines of HIV prevalence in clients and general population, as evidenced by the declining trends of HIV prevalence among antenatal clinic attendees in later years. While the levels of HIV among clients were estimated to be less than that among FSW, the declining trend follows a course similar to FSW, with a gap of 3-5 years. Antenatal clinic attendees have also shown a consistently declining trend in the state, peaking above 1% in the year 2000, and then declining to low levels of around 0.4% in recent years. The same are reflected in trends of HIV prevalence among clients, general population males and females (15-49 years). Also, general population males have shown higher prevalence levels than females throughout the duration of the epidemic, though they too follow a similar trend.[28]

The epidemic among MSM in Karnataka has shown moderate to high levels of HIV prevalence and trends have been declining over time. MSM is the second most important key population in the state with a large number of KP in most of the districts. However, targeted interventions have been set up and scaled up to saturate the MSM population in the state, leading to further containment of the epidemic among them.

PWID are a very small group in the state, and identified only in the capital city of Bangalore in small numbers. As such, PWID do not greatly contribute to the overall epidemic in the state. The levels of HIV prevalence among the PWID have been low at around 2% and trends have been stable over the years.

Modelled estimates have also shown that the number of PLHIV has been declining in the state, as more deaths were occurring than new infections, each year.[3] This is because of the rapid scale up of prevention interventions since the early 1990s, much before the initiation and scale up of treatment programs from 2004 onwards. Thus, new infections have started declining rapidly since early 2000, while deaths started to decline only after 2005. Due to the higher number of deaths than new infections occurring annually, the overall HIV burden consistently declined over the years.

Across estimates of PLHIV, new infections, and deaths, the general population accounts for around 85% of the cases, while clients of FSW account for another 10%, key populations of FSW and MSM account for around 5% of all new infections and deaths. Though the trends have been declining, this proportional distribution has remained more or less consistent.

Thus, the epidemic in Karnataka is a concentrated epidemic, driven largely by heterosexual networks and partly by MSM networks; an epidemic that had started over two decades ago and has matured over time with consistent declines in new infections and deaths among KP as well as GP. New infections and deaths have reached a very low level owing to long-standing scaled up high intensity prevention and treatment programs, which have almost saturated target groups. HIV transmission among KP has been reduced to a low level, its prevalence and burden remains high. Further, HIV transmission in the general population accounts for most of the new infections in the current scenario, and interventions that will address this will become crucial for the HIV programs in the state in the coming years. Also, reaching the last mile unreached population of KP as well as GP with treatment programs is very critical to ensure that all PLHIV lead a healthy and productive life.

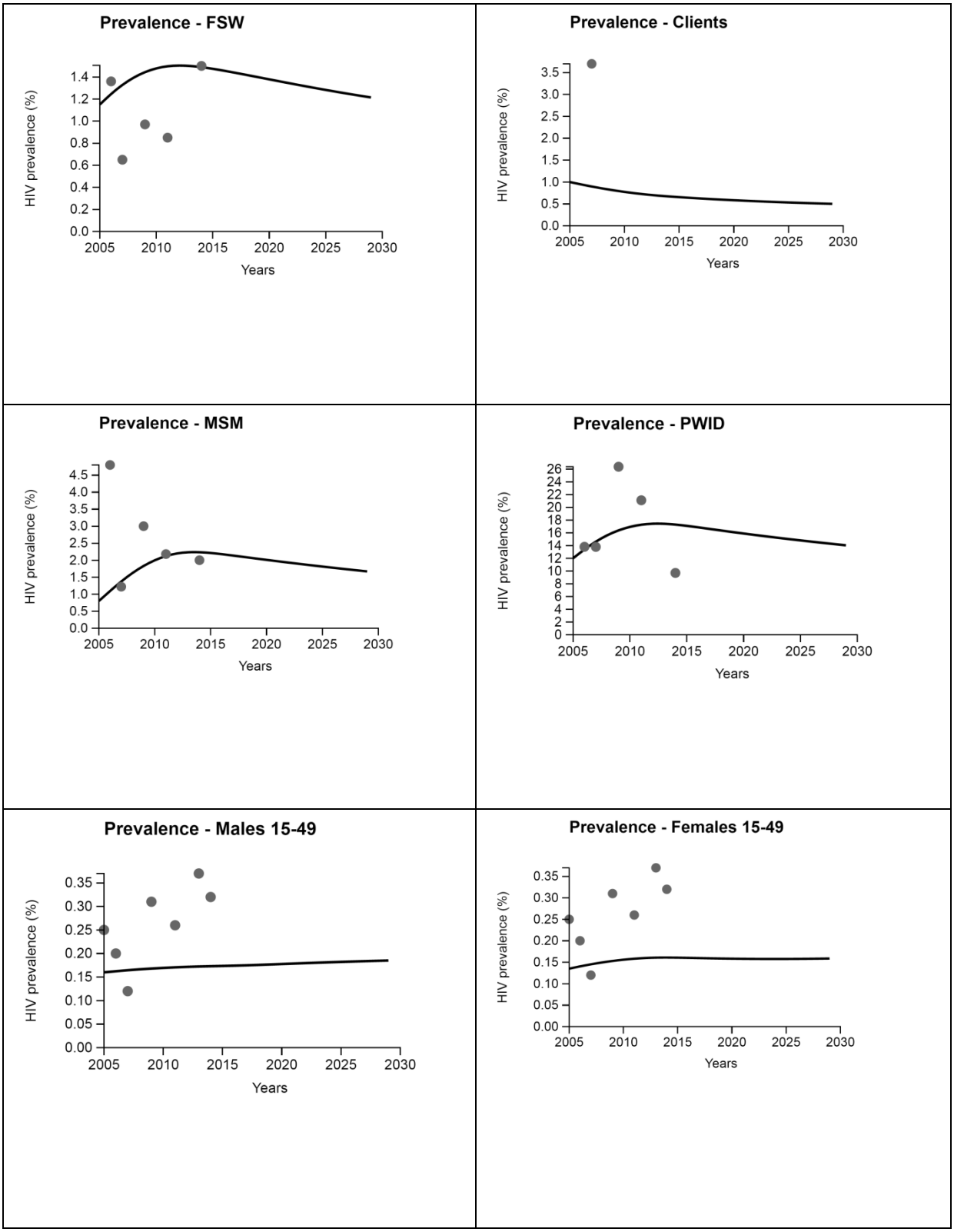
Punjab

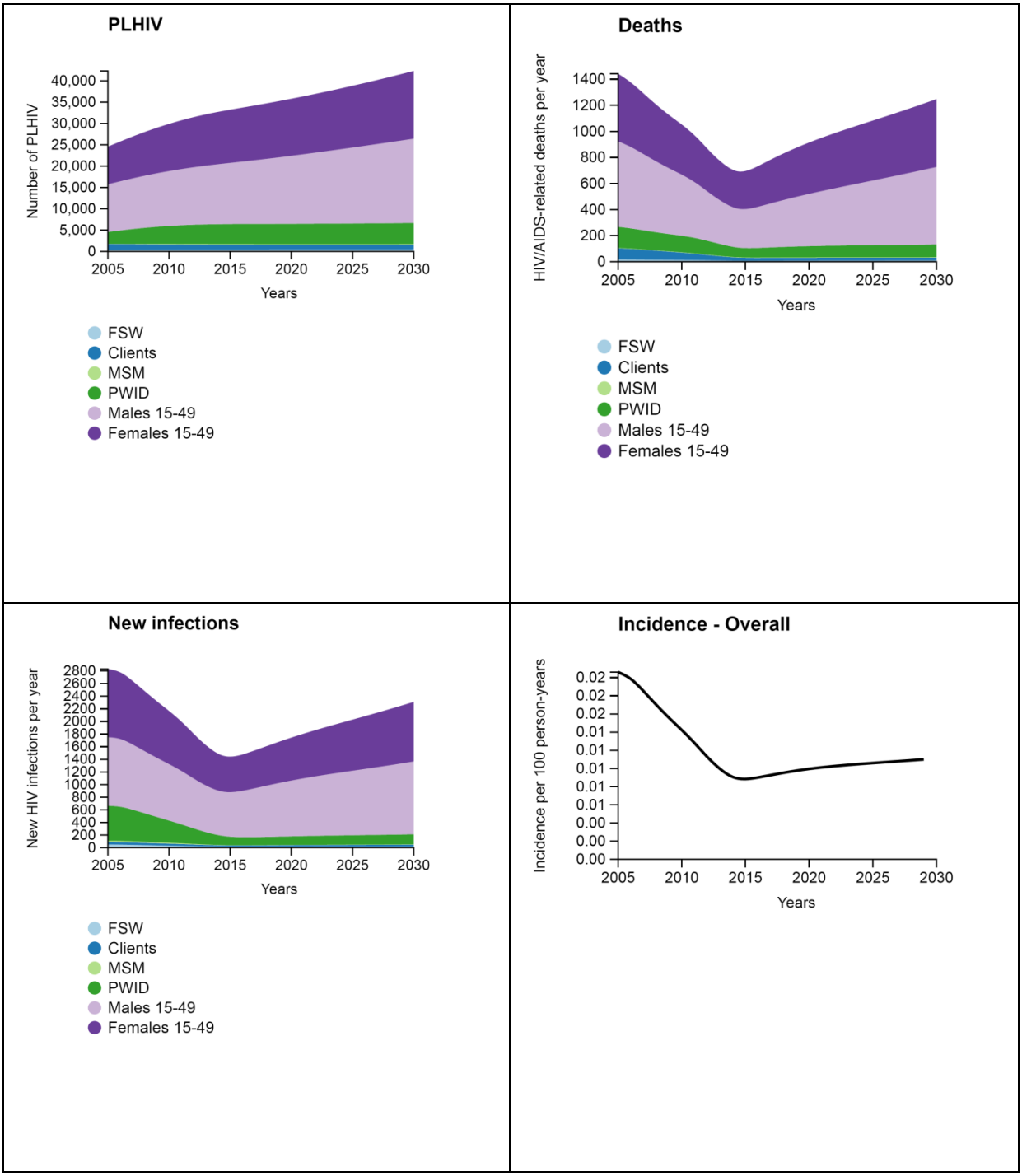
The HIV epidemic in Punjab is largely a PWID-driven epidemic with a very large network of people who consume drugs by oral as well as injecting routes. Almost every district in the state has over 1,000 PWID, with a large proportion sharing needles. HIV prevalence has rapidly increased among PWID in the state from 2005 onwards, and has reached alarming levels of around 50% at some HSS sites[26]Though the epidemic stabilised at a higher level of around 10-12% HIV prevalence, there are pockets with much higher prevalence and rising prevalence trends. In addition to established needle syringe exchange OST is being provided to saturate the coverage of PWID though Targeted Intervention program interventions. The slower decline in the prevalence of the PWID epidemic may be due to the impact of prevention programs and also reduction in deaths (as many are on OST, thus death due to overdoses may have declined), and due to ART.

The HIV epidemic among the general population which had remained stable and low at around 0.2% for a considerable period, has recently exhibited rising trends. Consistent sites have shown rising trends of HIV prevalence among antenatal clinic attendees. More and more pockets have started showing moderate to high HIV prevalence among them.[29][30]Accordingly, the PLHIV burden in the state is also increasing gradually, and as is

the case in any concentrated epidemic, around 90% of the burden is among the general population.

Figure-6.2: Calibrated Epidemic Curves – Punjab





While the transmission dynamics among general population are still not clear, epidemics among PWID appear to have directly or indirectly contributed to the spread of HIV in the general population. New HIV infections in the state have shown gradually rising trends until around 2007, followed by a declining trend, concomitant with the rise and fall of the PWID epidemic in the state. AIDS deaths have also been rising in the state until the initiation of an ART program in 2004, after which time deaths have started declining. The state has shown a very low-level stable epidemic among FSW and MSM, which is stable at around 2% HIV prevalence over many years. Hence, heterosexual and homosexual transmissions are considered secondary drivers for the HIV epidemic in the state. Thus, the HIV epidemic in the state of Punjab is a recent, rising epidemic predominantly driven by PWID networks that have higher levels of HIV, with rising trends in some pockets. Epidemics among FSW and

MSM are low and stable. The fact that trends have started to rise among general population demands utmost focus on prevention of transmission among the key driver populations and the general population.

The above epidemic curves have been compared with SPECTRUM (another HIV epidemic modelling tool used by the Government of India) modelled estimates, which are published in the national report.[25] The Optima calibration is consistent with SPECTRUM estimates (Annex12).

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Results

Most of the results described have four key time frames:

- 2007- Beginning of NACP-III and baseline for NACP-IV targets
- 2017- Planned end of NACP-IV
- 2010- Baseline for SDG goals
- 2030- Planned end year of SDG

How close are we to National Strategic Plan (NSP) targets undercurrent funding?

Two key secondary questions were considered to arrive at the above policy question.

- With the current volume of funding, allocated according to current expenditure?
- With the current volume of funding, allocated optimally with given constraints
  a. No one who initiates ART or OST is to stop receiving treatment, except through natural attrition
  b. Limit scale down of key population[7] (KP) programs to 75% of current funding levels.

The results of this analysis are given in Table 7.1

Table 7.1: Number of new HIV infections and deaths in the current scenario and optimized funding scenario

State	Year	Annual No of New infections		No of Deaths		Change[8] in No of New infections (%)		Change[9] in No of Deaths (%)	
Karnataka		Current	Optimal	Current	Optimal	Current	Optimal	Current	Optimal
	2007	6929	6929	14026	14026				
	2010	5177	5177	10342	10342				
	2017	2277	1113	4184	1351	67	84	70	90
	2030	1371	916	2300	1266	74	82	78	88
Punjab									
	2007	2633	2633	1281	1281				
	2010	2136	2136	1039	1039				
	2017	1690	1063	809	426	36	60	37	67
	2030	2589	1231	1307	551	-21	42	-26	47

With current levels of funding in the state of Karnataka:

- By the year 2017, there will be an estimated 67% reduction in the number of new infections and a 70% reduction in number of deaths compared to 2007 levels

[7] Karnataka and Punjab studies both incorporate the following key populations: female sex workers (FSW), clients of female sex workers (Clients), men who have sex with men (MSM), people who inject drugs (PWID).

[8] For 2017 baseline was 2007, for 2030 baseline was 2010 for all tables

[9] For 2017 baseline was 2007, for 2030 baseline was 2010 for all tables

- By the year 2030, there will be an estimated 74% reduction in the number of new infections and a 78% reduction in deaths compared to 2010 levels

With current levels of funding in the state of Punjab:

- By the year 2017, there will be an estimated 36% reduction in the number of new infections and a 37% reduction in number of deaths compared to 2007 levels
- By the year 2030, there will be an estimated 21% increase in the number of new infections and a 26% increase in deaths compared to 2010 levels

Graphs- 7.1: Changing trends in epidemic curves with optimal allocation of current funds,2016-2030

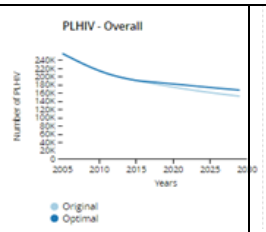
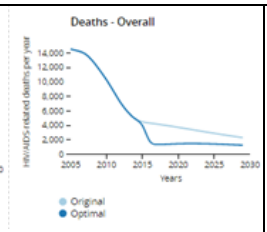
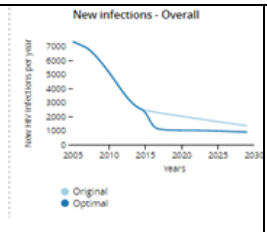
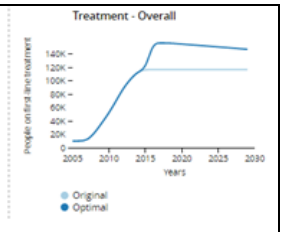
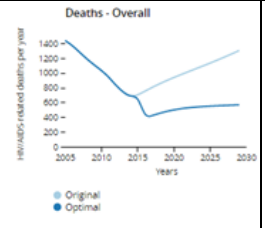
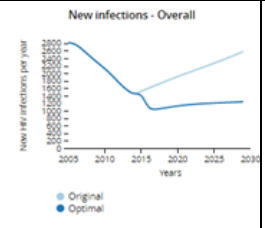
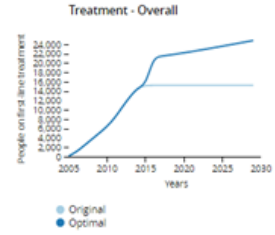
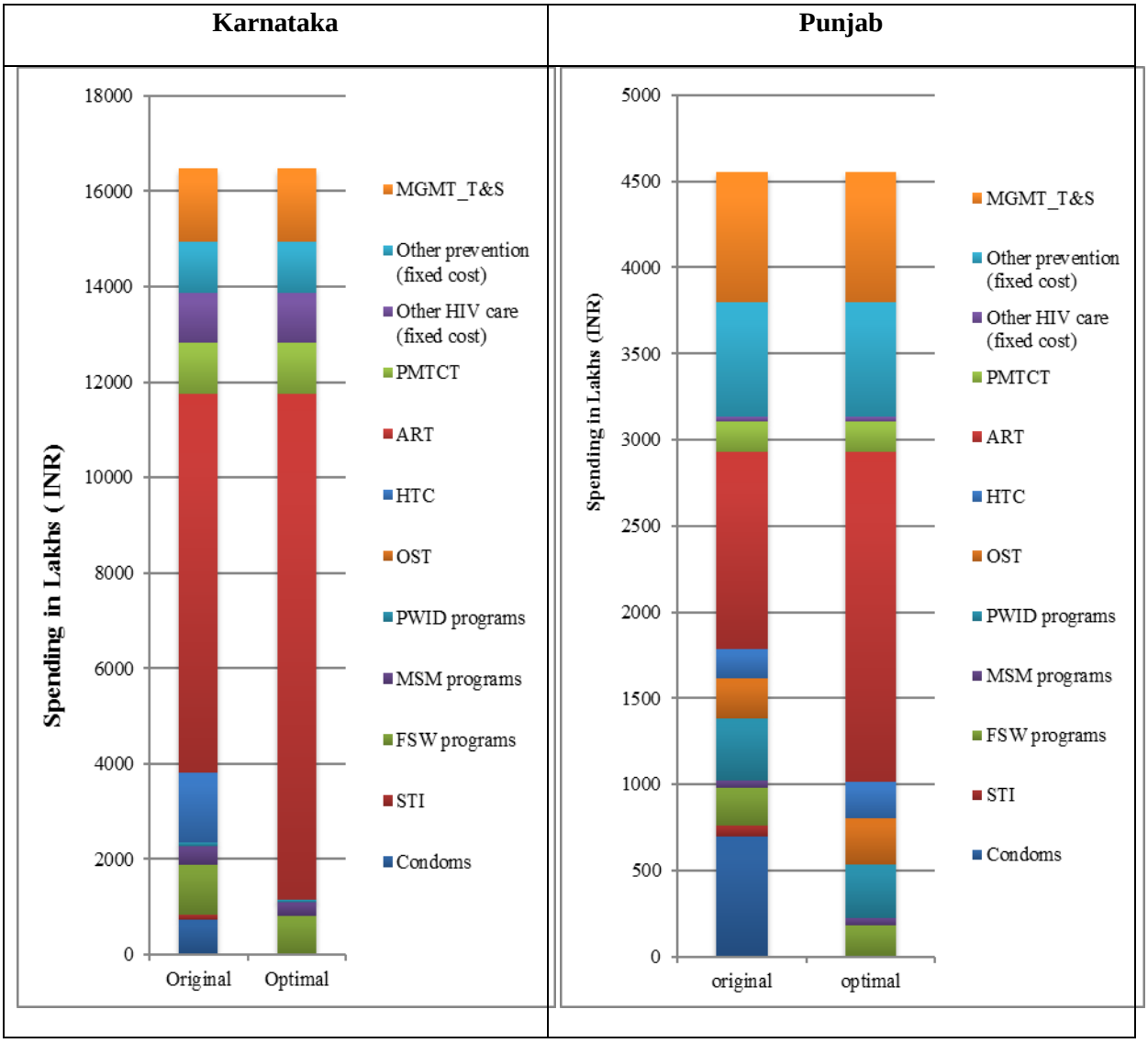
Karnataka				
Punjab				

Chart 7.1: Comparison of current and optimal allocation of funds in Karnataka and Punjab



In Karnataka, optimization of program priorities without increase in spending shows that the greatest impact can be achieved by increasing funding to ART by 1.3 times current levels, while sex worker programs, OST, other condom distribution and PMTCT should all maintain similar levels of funding. These identified priority programs should be complemented by other programs only if additional resources can be made available. This optimalallocation is estimated to have the following impact:

- Put around 40,000 more people annually on ART, will avert around 11,500 new infections and 27,000 deaths, between 2016 to 2030
- By the year 2017, there will be 84% reduction in the number of new infections and 90% reduction in number of deaths from 2007 levels
- By the year 2030, there will be 82% reduction in the number of new infections and 88% reduction in deaths from 2010 level
- The cost of avoiding a new infection from year 2016 to year 2030 will be approximately INR-2,150,791 and averting a death is INR-917,078 for the same period.

In Punjab, optimization of program priorities without increase in spending shows that the greatest impact can be achieved by increasing funding to ART by 1.6 times current levels, OST should increase 1.2 times current levels and PWID programs should be maintained as priority. To support the increase in ART programs, it is also important to increase HTC programs (by up to 50%). These identified priority programs should be the focus of the HIV response and only complemented by other programs if substantial additional resources are made available. This optimalallocation is estimated to have the following impact:

- Putting around 6,000 more people annually on ART, will avert around 13,000 new infections and 7,400 deaths between 2016 to 2030
- By the year 2017, there will be 60% reduction in the number of new infections and 67% reduction in number of deaths from 2007 levels
- By the year 2030, there will be 42% decrease in the number of new infections and 46% decrease in deaths from 2010 level.
- The cost of avoiding a new infection from year 2016 to year 2030 will be approximately INR-525,844 and averting a death is INR-923,850 for the same period.

What could be achieved if budgets are scaled up by 25%?

Table 7.2: Number of new HIV infections and deaths in the current scenario and optimized funding scenario with 25% budget scale-up

State	Year	No of New infection		No of Deaths		Change in No of New infections%		Change in No of Deaths%	
Karnataka		Current	Optimal	Current	Optimal	Current	Optimal	Current	Optimal
	2007	6929	6929	14026	14026				
	2010	5177	5177	10342	10342				

State	Year	No of New infection		No of Deaths		Change in No of New infections%		Change in No of Deaths%	
	2017	2277	1045	4184	1204	67	85	70	91
	2030	1371	741	2300	879	74	86	78	92
Punjab									
	2007	2633	2633	1281	1281				
	2010	2136	2136	1039	1039				
	2017	1690	1017	809	424	36	61	37	67
	2030	2589	1179	1307	544	-21	45	-26	48

With 25% increase in level of funding in the state of Karnataka, allocated optimally:

- By 2017, there will be an estimated85% reduction in the number of new infections and 91% reduction in number of deaths compared to 2007 levels
- By 2030, there will be an estimated 86% reduction in the number of new infections and 92% reduction in deaths compared to 2010 levels

With 25% increase in level of funding in the state of Punjab, allocated optimally:

- By 2017, there will be an estimated 61% reduction in the number of new infections and 67% reduction in number of deaths compared to 2007 levels
- By 2030, there will be an estimated 45% reduction in the number of new infections and 48% reduction in deaths compared to 2010 levels

Graphs- 7.2: Changing trend of epidemic curves with optimal allocation of 25% increase in optimizable budget, 2016-2030

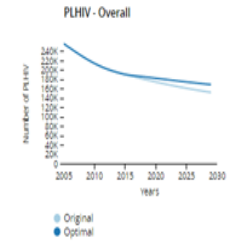
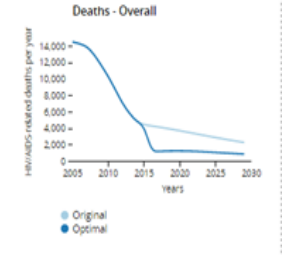
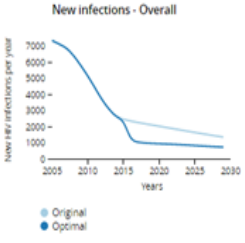
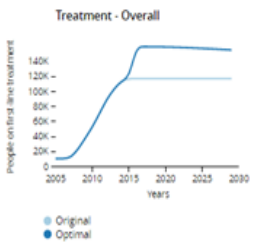
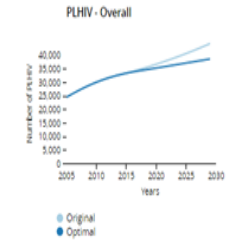
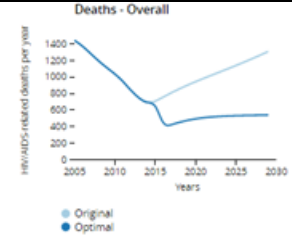
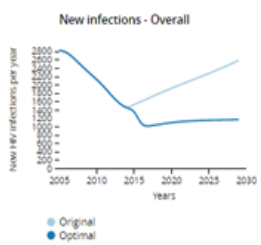
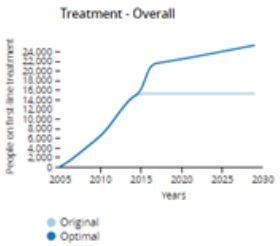
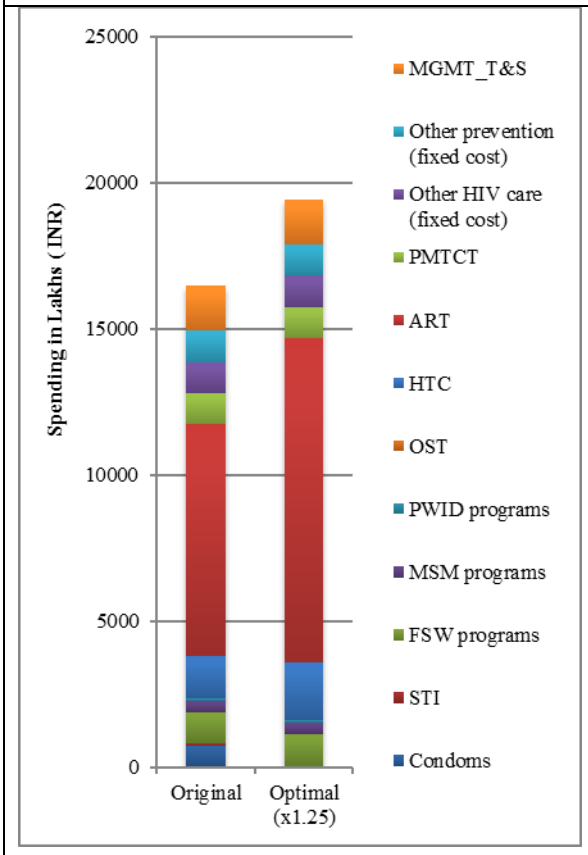
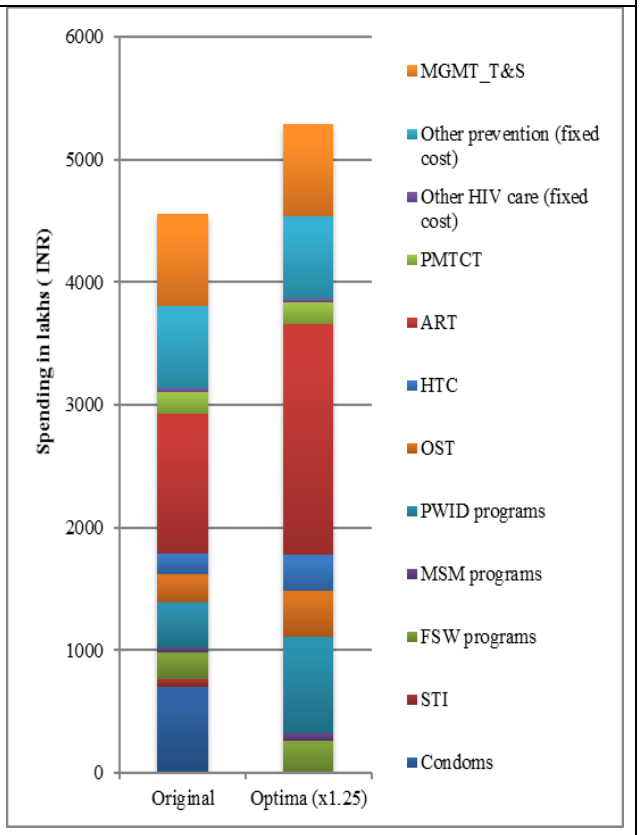
Karnataka				
Punjab				

Chart 7.2: Comparison of current and optimal allocation of 25% increase in funds in Karnataka and Punjab

Karnataka	Punjab
	

In Karnataka, optimization of program priorities with 25% increase in spending shows that the greatest impact can be achieved by increasing funding to ART, OST and HTC by 1.3 times current levels, while sex worker programs, MSM, PWID and PMTCT should all maintain similar levels of funding, STI and Condom program for general population should be defunded. These identified priority programs should be complemented by other programs only if additional resources can be made available. This will also result in 42,000 additional people on treatment and is estimated to avert around 13,000 new infections and 30,000 deaths, through the period 2016-2030. The cost of avoiding a new infection from year 2016 to year 2030 will be approximately INR-2,242,015 and averting a death is INR-971,540 for the same period.

In Punjab, optimization of program priorities with 25% increase in spending shows that the greatest impact can be achieved by increasing funding to PWID program by 2, HTC by 1.7 times, ART by 1.6 times, OST by 1.6 times and, Sex worker program by 1.2 times, MSM program by 1.2 times times of current levels. These identified priority programs should be complemented by other programs only if additional resources can be made available. This will also result in 6,000 more people on treatment and is estimated to avert around 13,700 new infections and 7,500 deaths between 2016-2030. The cost of avoiding a new infection from year 2016 to year 2030 will be approximately INR-579,513 and averting a death is INR-1,057,920 for the same period.

What could be achieved if budgets are scaled up by 50%?

Table 7.3: Number of new infections and deaths in the current scenario and optimized funding scenario with 50% budget scale-up

State	Year	No of New infection		No of Deaths		Change in No of New infections%		Change in No of Deaths%	
Karnataka		**Current**	**Optimal**	**Current**	**Optimal**	**Current**	**Optimal**	**Current**	**Optimal**
	2007	6929	6929	14026	14026				
	2010	5177	5177	10342	10342				
	2017	2277	1004	4184	1100	67	86	70	92
	2030	1371	567	2300	483	74	89	78	95
Punjab									
	2007	2633	2633	1281	1281				
	2010	2136	2136	1039	1039				
	2017	1690	1005	809	423	36	62	37	67
	2030	2589	1164	1307	541	-21	46	-26	48

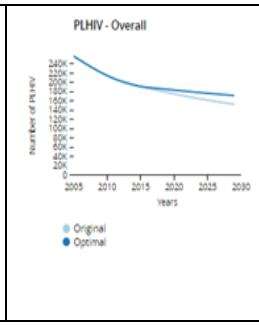
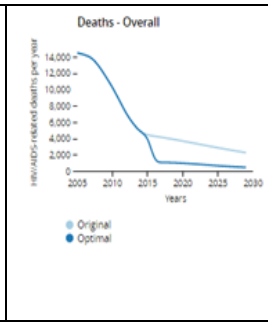
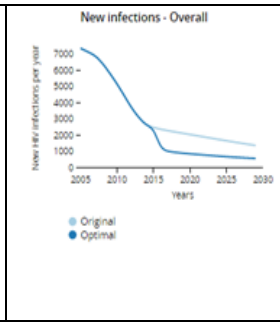
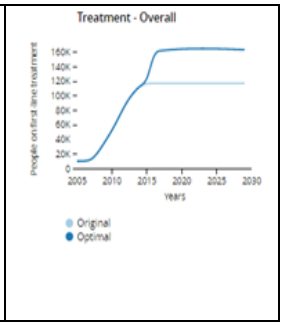
With a 50% increase in level of funding in the state of Karnataka, allocated optimally:

- By 2017, an estimated86% reduction in the number of new infections and 92% reduction in number of deaths can be realised compared to2007 levels
- By 2030, an estimated 89% reduction in the number of new infections and 95% reduction in number of deaths can be realised compared to 2010 levels

With a 50% increase in level of funding in the state of Punjab, allocated optimally:

- By 2017, we estimate that itis possible to achieve a 62% reduction in the number of new infections and 67% reduction in number of deaths compared to 2007 levels
- By 2030, we estimate that it is possible to achieve a 46% reduction in the number of new infections and 48% reduction in number of deaths compared to 2010 levels

Graphs- 7.3: Changing trend of epidemic curves with optimal allocation of 50% increase in budget, 2016-2030

Karnataka				

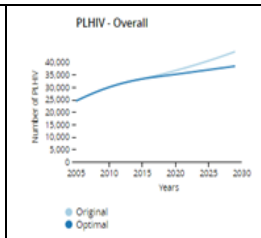
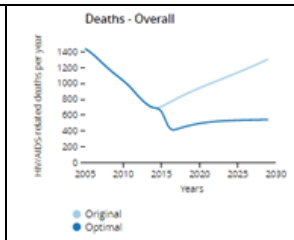
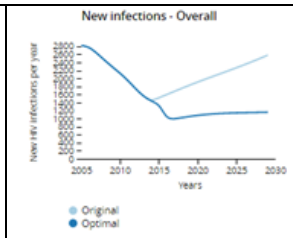
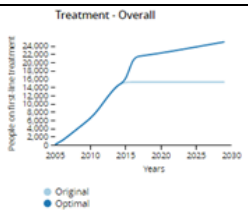
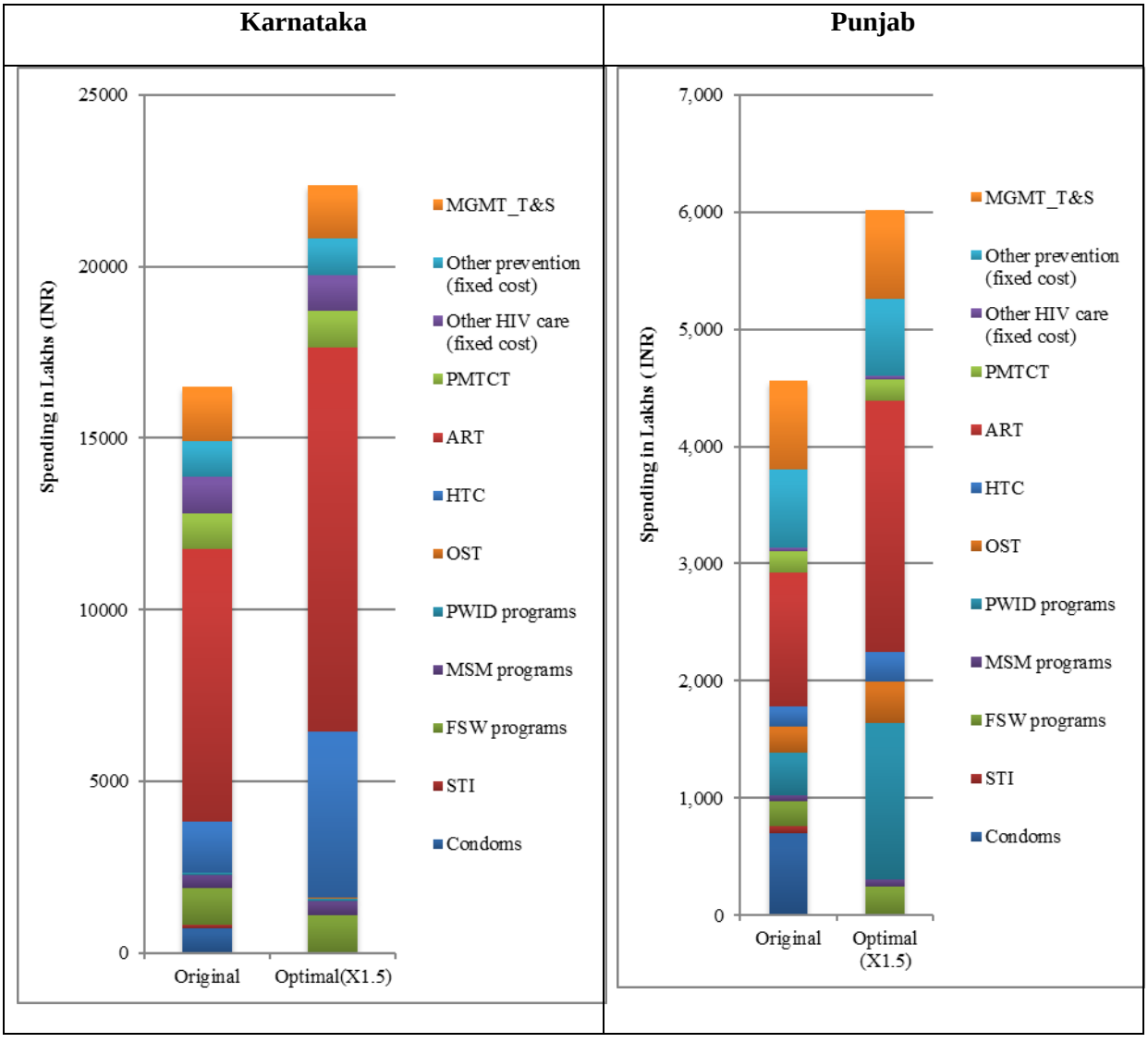
Punjab				

Chart 7.3: Comparison of current and optimal allocation of 50% increase in funds in Karnataka and Punjab



In Karnataka, optimization of program priorities with 50% increase in spending shows that the greatest impact can be achieved by increasing funding to HTC by 3.3 times,ART by 1.4 times and OST by 1.3 times current levels, while sex worker programs, MSM,PWID and PMTCT should all maintain similar levels of funding,

STI and Condom program for general population should be defunded. These identified priority programs should be complemented by other programs only if additional resources can be made available. This will also result in around 45,000 more people annually on ART, and is estimated to avert around 15,000 new infections and 35,000 deaths, from 2016 to 2030. The cost of avoiding a new infection from year 2016 to year 2030 will be approximately INR-2,237,219 and averting a death is INR-985,808 for the same period.

In Punjab, optimization of program priorities with 50% increase in spending shows that the greatest impact can be achieved by increasing funding to PWID program by 3.3 times, ART by 1.8 times, OST by 1.8 times and HTC by 1.7 times, Sex worker program by 1.4 times and MSM program by 1.3 times of current levels. These identified priority programs should be complemented by other programs only if additional resources can be made available. This will also result 6,000 more people annually on ART, and is estimated to avert around 13,800 new infections and 7,500 deaths, from 2016 to 2030. The cost of avoiding a new infection from year 2016 to year 2030 will be approximately INR-654,515 and averting a death is INR-1,204,308 for the same period.

What benefits can be achieved via implementation efficiency gains?

For fixed-cost programs: a 20% reduction in costs was used to understand the effect of efficiency gain on the program results in both states.

Table 7.4: Number of new infections and deaths in the current scenario and optimized funding scenario with 20% implementation efficiency gain in fixed cost programs

State	Year	No of New infection		No of Deaths		Change in No of New infections%		Change in No of Deaths%	
Karnataka		**Current**	**Optimal**	**Current**	**Optimal**	**Current**	**Optimal**	**Current**	**Optimal**
	2007	6929	6929	14026	14026				
	2010	5177	5177	10342	10342				
	2017	2277	1074	4184	1259	67	84	70	91
	2030	1371	876	2300	1177	74	83	78	89
Punjab									
	2007	2633	2633	1281	1281				
	2010	2136	2136	1039	1039				
	2017	1690	1028	809	426	36	61	37	67
	2030	2589	1226	1307	568	-21	43	-26	45

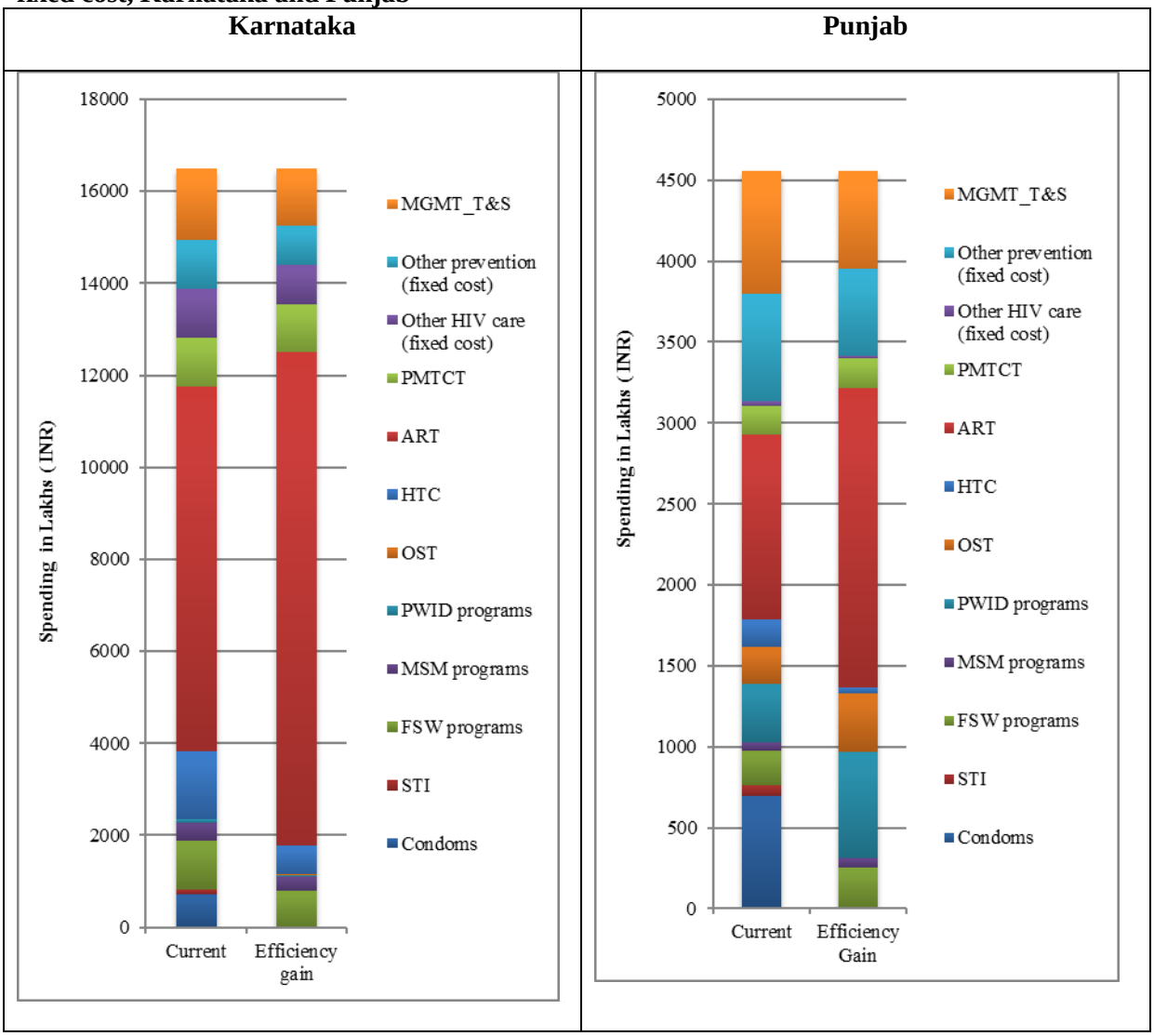
With 20% gain in efficiency of fixed cost programs in the state of Karnataka, allocated optimally:

- By 2017,we can achieve an84% reduction in the number of new infections and 91% reduction in number of deaths compared to 2007 levels simply by optimally allocating existing budget levels with 20% implementation efficiency gains
- By 2030, we can achieve an83% reduction in the number of new infections and 89% reduction in number of deaths compared to 2010 levels simply by optimally allocating existing budget levels with 20% implementation efficiency gains

With 20% gain in efficiency of fixed cost programs in the state of Punjab, allocated optimally:

- By the year 2017, there will be 61% reduction in the number of new infections and 67% reduction in number of deaths from 2007 levels
- By the year 2030, there will be 43% reduction in the number of new infections and 45%reduction in deaths from 2010 levels

Chart 7.4 Comparison of current and optimal allocation of funds with 20% efficiency gain in fixed cost, Karnataka and Punjab



In Karnataka Optimization with 20% efficiency gain in fixed cost spending shows that condom, and STI program needs to be defunded. the ART program spending will have to increase by 1.3 times, TI program and OST funding will reduce by 75%.While spending on HIV testing will reduce by 50%,. This will result in 41,000 more people annually on ART, and is estimated to avert around 12,000 new infections and 28,000 deaths, from 2016 to 2030. The cost of avoiding a new infection from year 2016 to year 2030 will be approximately INR-2,061,165 and averting a death is INR-883,361 for the same period

In Punjab Optimization with Optimization with 20% efficiency gain in fixed cost spending shows that while the condom and STI program will be defunded, spending will increase in PWID program by 1.8 times, ART and OST program by 1.6 times each, FSW and MSM program by 1.2 time each. HIV testing program will be defunded by 80%.This will result in putting around 6,000 more people annually on ART, and is estimated to avert around 13,300 new infections and 7,300 deaths from2016 to 2030. The cost of avoiding a new infection from year 2016 to year 2030 will be approximately INR-514,022 and averting a death is INR-936,055 for the same period

How much funding is required to achieve the 2030 targets

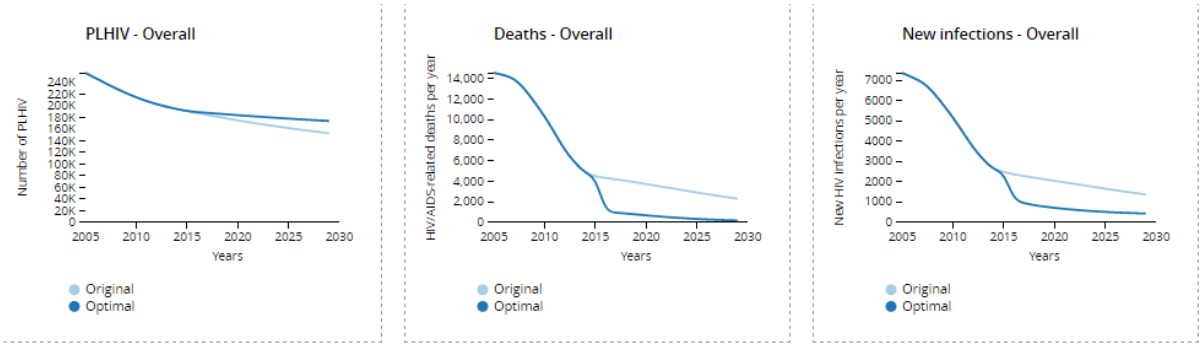
Karnataka:

Table 7.5.1:Number of new infections and deaths in the current scenario and optimized funding scenario to achieve2030 goals

Year	No of New infection		No of Deaths		Change in No of New infections%		Change in No of Deaths%	
	Current	Optimal	Current	Optimal	Current	Optimal	Current	Optimal
2010	5177	5177	10342	10342				
2030	1371	430	2300	177	74	92	78	98

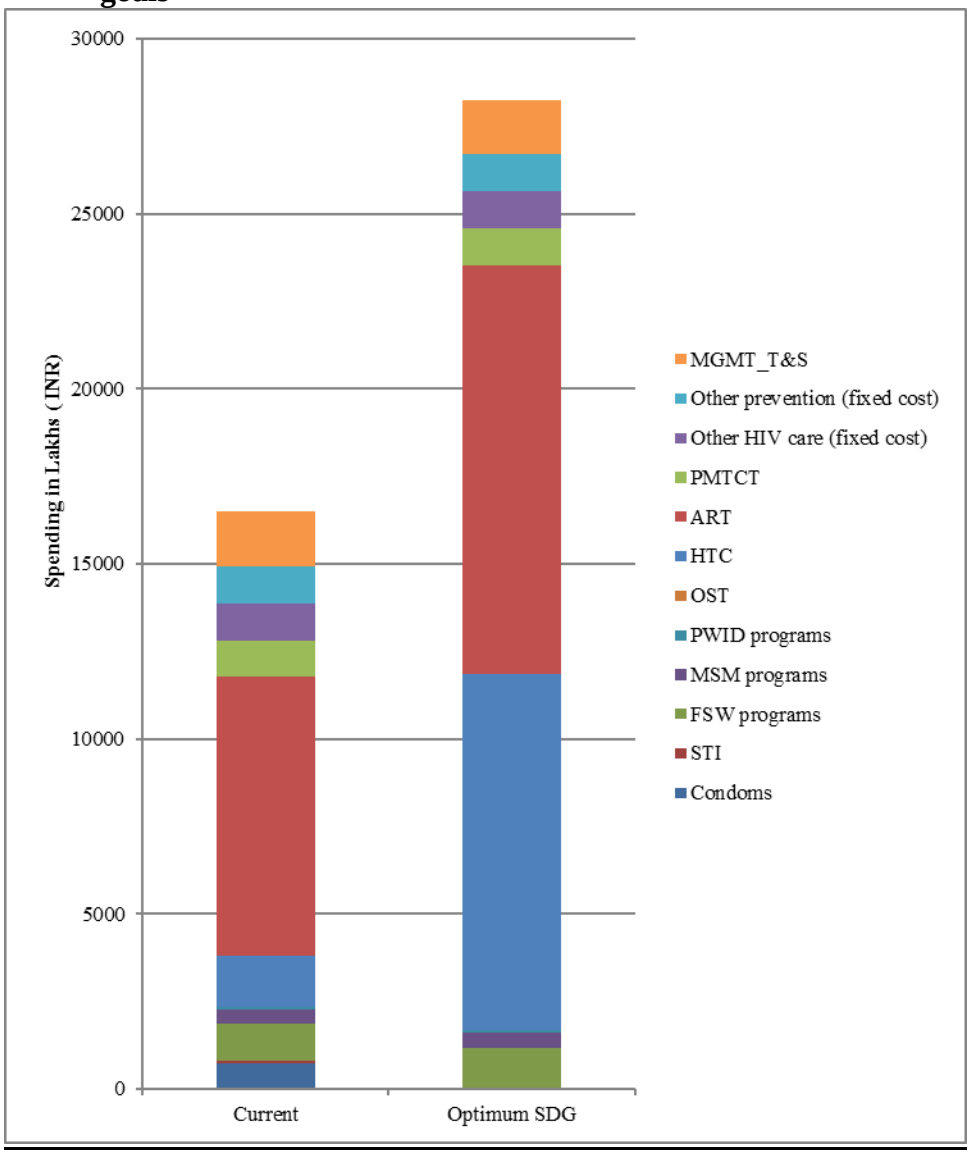
Compared to 2010 values a reduction in new infections, 92% and reduction in deaths up to 98% by 2030 is achievable with a total budget of INR 2,82,54,98,742 (i.e. approximately 1.72 times current total budget.

Graph 7.5.1 Number of new infections and deaths in the current scenario and optimized funding scenario to reach 2030 goals



A sharp decline in new infections and deaths is expected to occur during the initial five years followed by continued albeit slow reduction in both the parameters until 2030.

Chart 7.5.1 **Comparison of current and optimal funds required in Karnataka to reach 2030 goals**



In order to achieve the SDG goals in Karnataka the required spending will have to be increased to 1.72 times current levels. The optimal allocation suggests a defunding of condom and STI programs, a slight increase in expenditure for key population interventions, and increases in spending to the HIV testing by 6 times, OST program by 1.4 times, ART program by 1.4 times of the current levels.

Punjab:

In the state of Punjab, even a high level of budgetary increase will not be sufficient to achieve desired results of a 90% reduction in the number of new infections and deaths by 2030 from the baseline value from 2010. The summary of all possible optimisations is outlined in Table 7.5.2.

Table 7.5.2: Optimised resource allocation envelopes and the impact on reduction in new infections and deaths in Punjab.

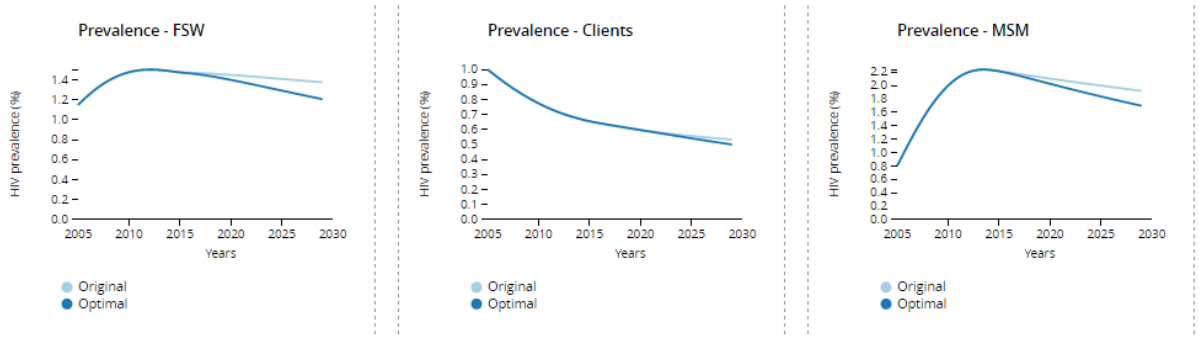
Optimisation Type	Total Budget (INR)	Infections Averted	Deaths Averted
Optimised Original Budget	45,57,65,874.88	42.35%	46.90%
2.28x Overall Budget (3x variable budget)	1,04,13,19,282.30	67.19%	75.91%
3.57x Overall Budget (5x variable budget)	1,62,68,72,689.73	81.74%	93.00%
4.85x Overall Budget (7x variable budget)	2,21,24,26,097.15	85.51%	97.09%
6.78x Overall Budget (10x variable budget)	3,09,07,56,208.29	87.50%	98.53%

Results corresponding to the optimization yielding to an 85% reduction in new infections and 97% reduction in deaths are given below.

Table 7.5.3: Number of new infections and deaths in the current scenario and optimized funding scenario to reach 2030 goals

Year	No of New infection		No of Deaths		Change in No of New infections%		Change in No of Deaths%	
	Current	Optimal	Current	Optimal	Current	Optimal	Current	Optimal
2010	2136	2136	1039	1039				
2030	2589	309	1307	30	-21	86	-26	97

Graph 7.5.2 Numberof new infections and deaths in the current scenario and optimized funding scenario to reach 2030 goals



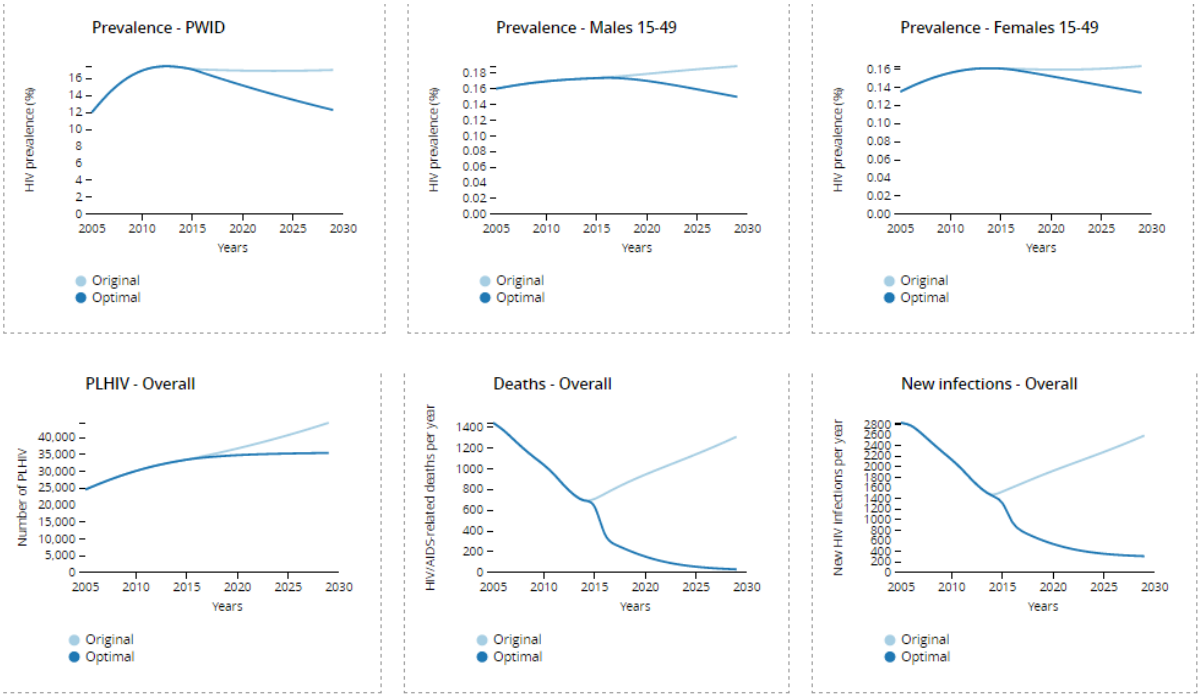
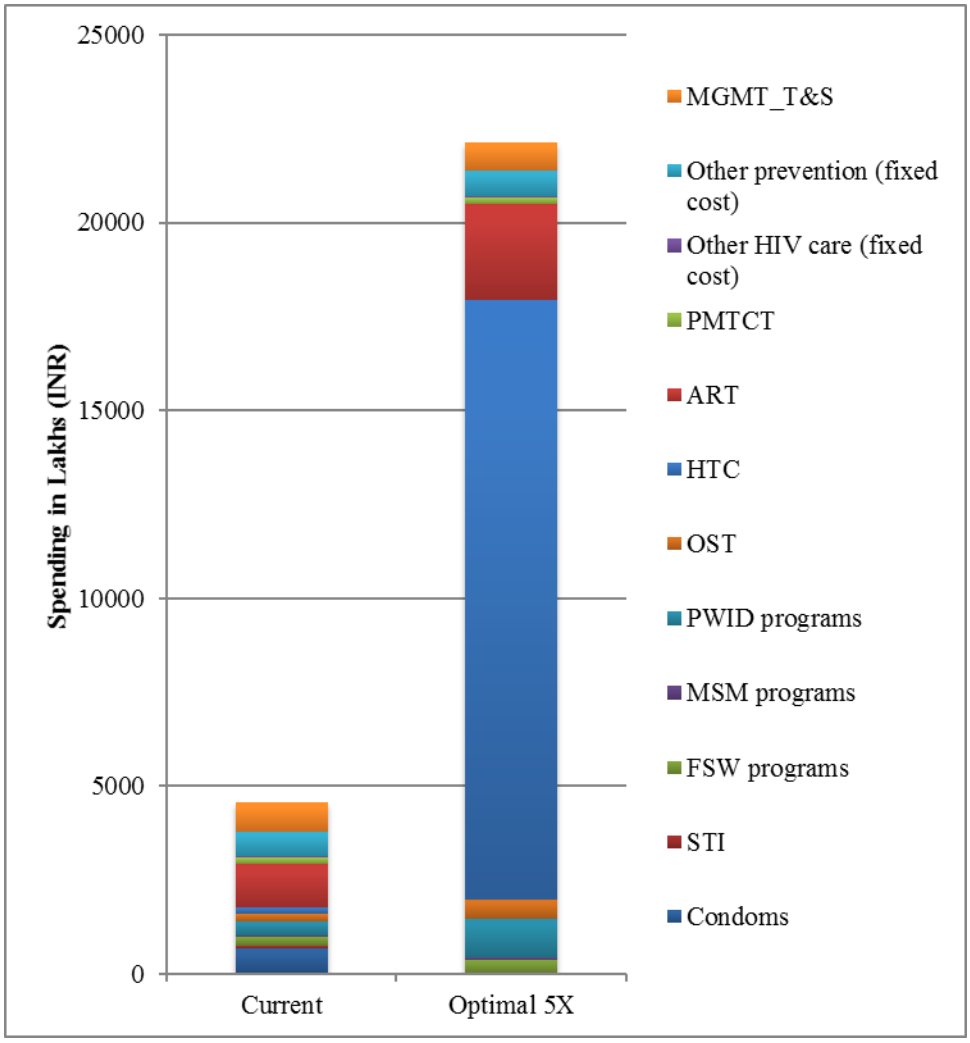


Chart 7.5.2 **Comparison of current and optimal funds required in Punjab to move towards reach 2030 goals**



The optimal allocation of funds 5 times more than the current budget will result in defunding of condom and STI program spending, increases in FSW and MSM spending by 1.6 times, PWID, OST and ART program spending by 2 times, and the HTC program by 90 times.

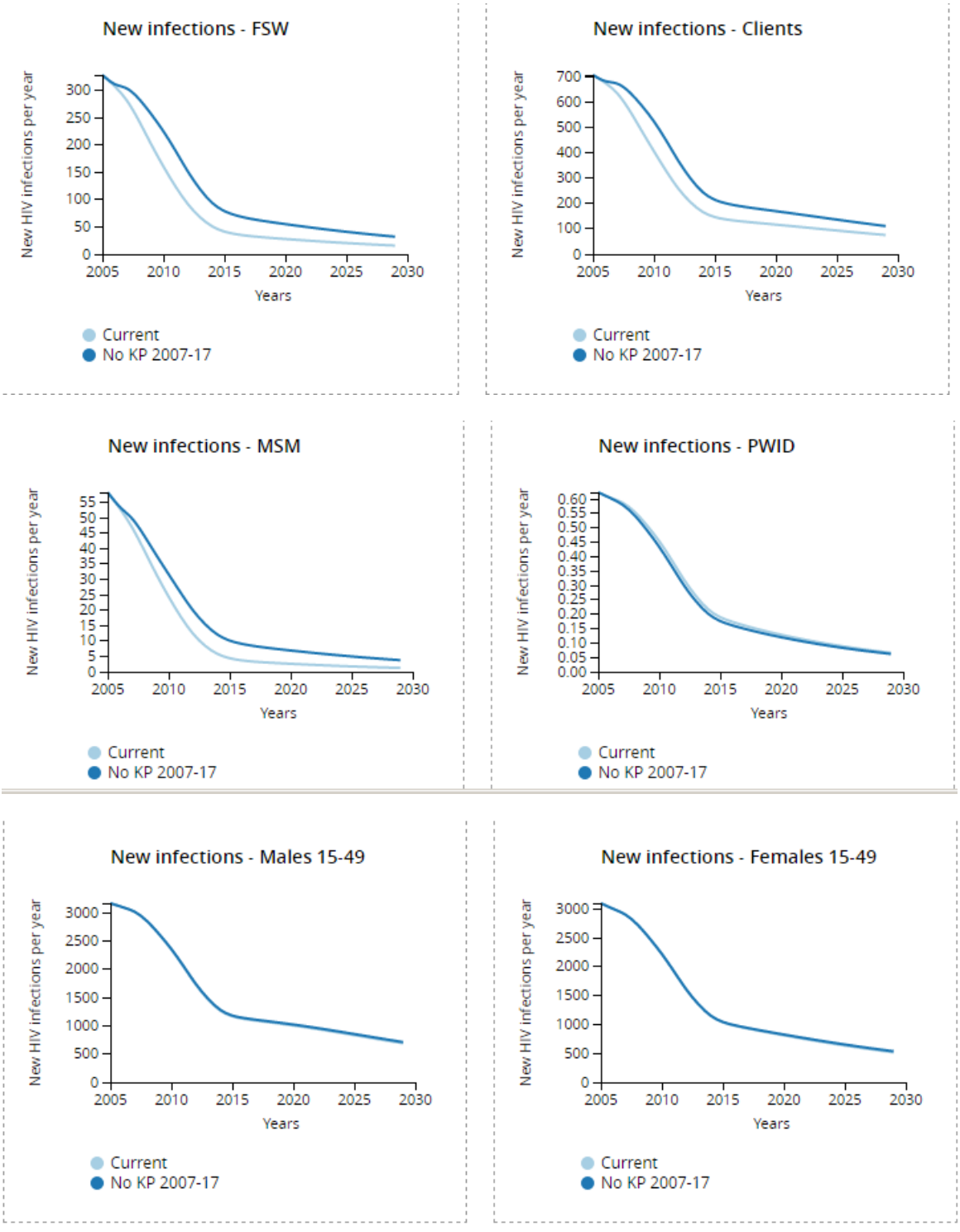
What have been the impacts of past program implementation?

Retrospectively, the impact on HIV epidemic in each state had investment not occurred in programs for key populations was investigated as well. A scenario was setup in this regards which considered the impact of no key population funding for 2007-2017.

Parameter values at 2007 were selected as the starting conditions for the scenario. The end parameter values for 2017 were set to be equal to initial values to simulate a zero programmatic funding for key populations.

Karnataka:

Graph 7.6.1: Comparison of number of new infections among different population groups in the absence of key population interventions, Karnataka



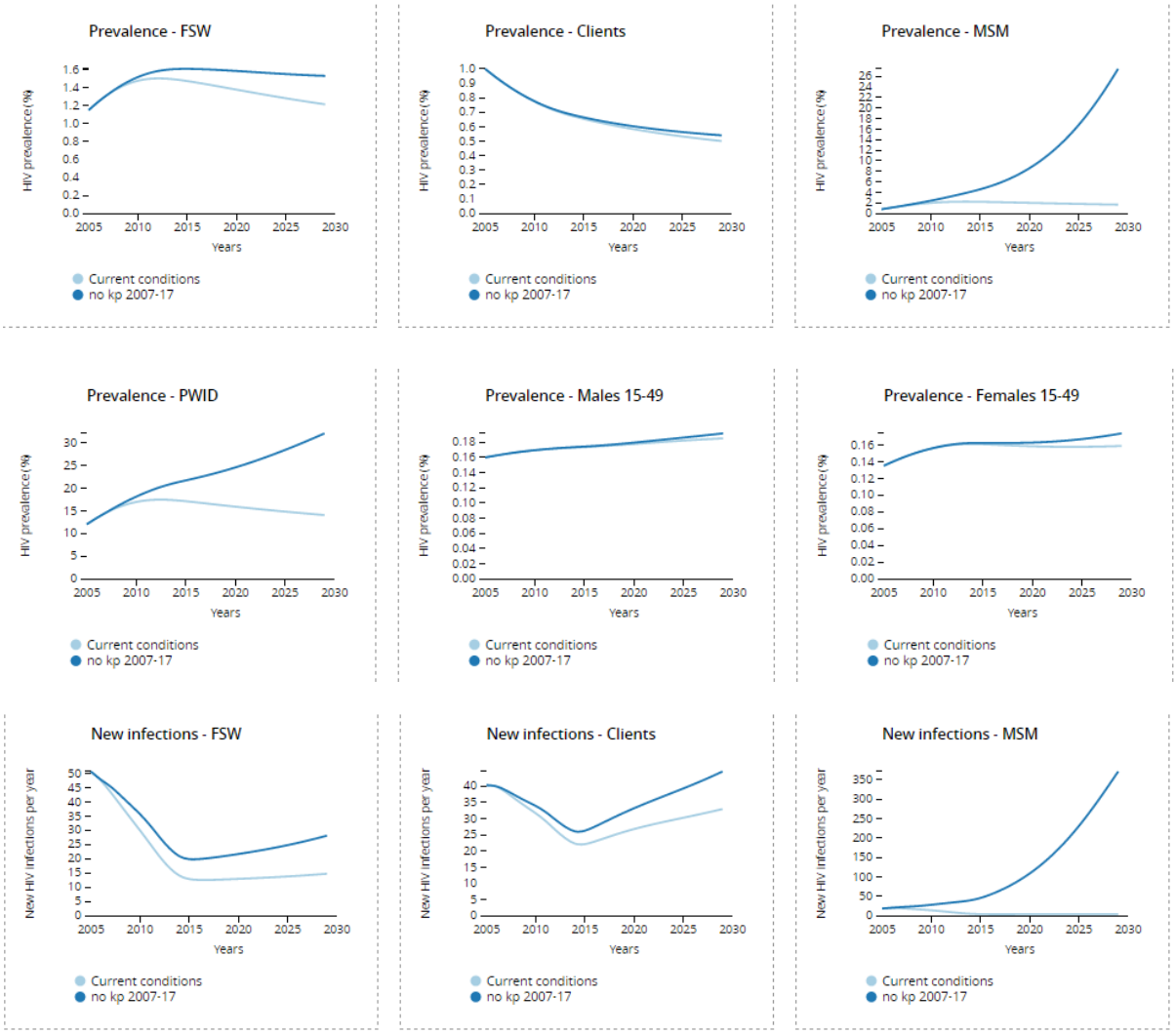
In the absence of KP programs, there would have been a relatively higher number of new infections among FSW, MSM and clients during the period 2007 to 2017. However, the impact on the trend in new infections would have remained the same among the general population and PWID.

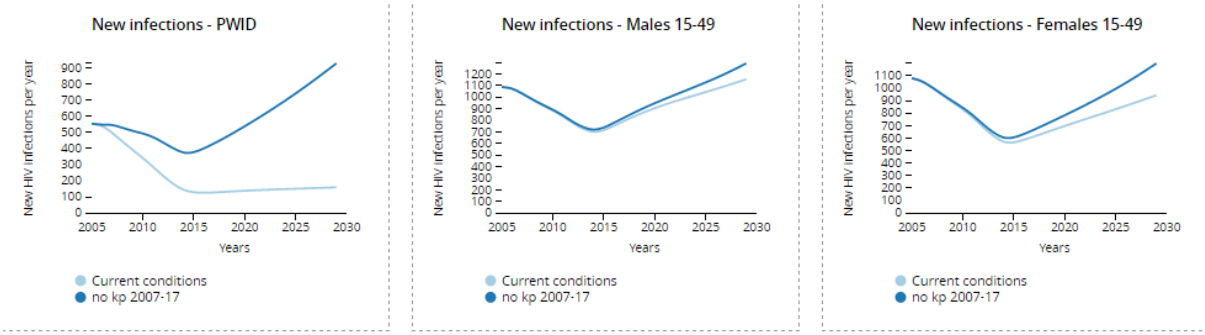
Table 7.6.1: Comparison of number of new infections among different population groups in the absence of key population interventions, Karnataka

Population	Current program		Program without KP	
	2006	2017	2006	2017
FSW	308.2	33.3	308.2	65.3
Clients of FSW	679.8	130.7	679.8	190.3
MSM	53.1	3.3	53.1	8.3
PWID	0.6	0.2	0.6	0.1
GP Male	3097.9	1088.6	3097.9	1104.8
GP Female	3097.9	1088.6	3097.9	1104.8

Punjab:

Graph 7.6.2: Comparison of number of new infections among different population groups in the absence of key population interventions, Punjab





The number of new infections and consequently HIV prevalence would have been much higher than current levels for all population groups. PWID and MSM key populations would have been impacted the most in terms of increased HIV prevalence and new infection trends in the absence of such programs.

Table 7.6.2: Comparison of number of new infections among different population groups in the absence of key population interventions, Punjab

	Current program			**Program without KP**	
Population	2006	2017		2006	2017
FSW	47.7	12.5		47.7	20.2
Clients of FSW	40.2	23.9		40.2	29.0
MSM	20.1	3.5		20.1	64.6
PWID	546.3	127.5		546.3	430.5
GP Male	1080.3	794.4		1080.3	822.9
GP Female	1060.5	612.8		1060.5	667.3

Initiating ART on CD4 count<500 and implications for the epidemic

For the following analysis, the budget was adjusted to include people eligible for treatment if the treatment eligibility criterion was at threshold CD4 <500. Due to a limit on the lower bound of number of people on treatment, the estimated new infections and deaths changed respectively.

Karnataka

Increased treatment eligibility of CD4 count from the current level of <350 to <500, with 25% expenditure than 2014-15 financial year expenditure allocated optimally shows that condom, and STI program needs to be defunded. While OST, MSM and PWID program funding will remain at the current level the spending on FSW program will increase by 2.8 fold while that of HIV testing will decrease by 80%, the ART program spending will have to increase by 10% and this will result in 72% reduction in new infections and 76% reduction in deaths by 2017 in comparison to respective values in 2007. This is also estimated to yield a 78% reduction in new infections and 83% reduction in deaths by 2030 in comparison to respective values in 2010.

Graph 7.7.1Number of new infections and deaths in the current scenario and optimized funding scenario with increased CD4 eligibility to <500.

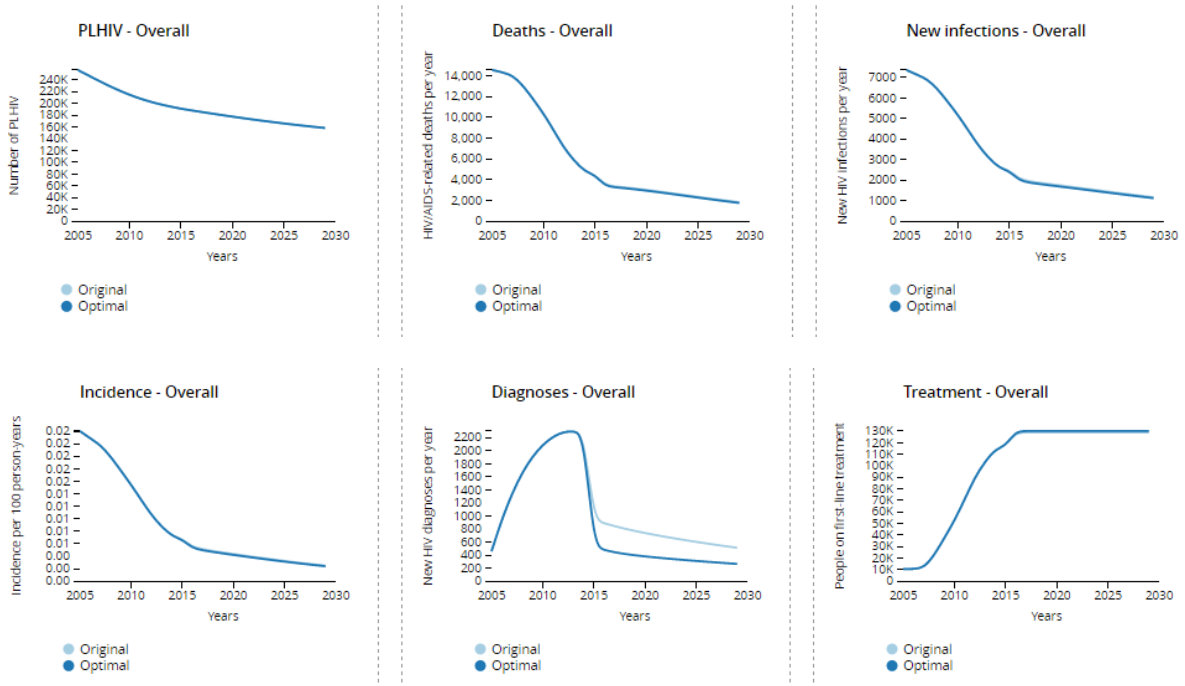
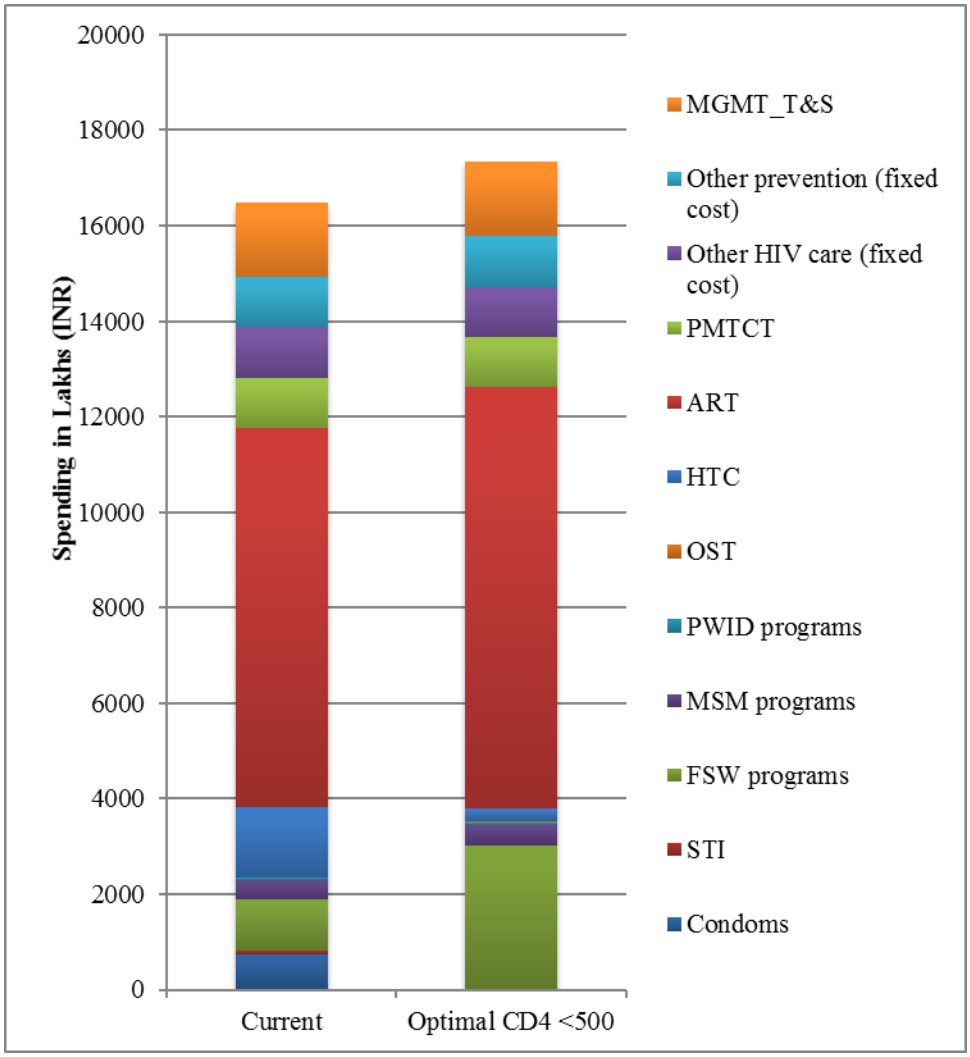


Chart 7.7.1 Comparison of current and optimal allocation with 25% more funds with CD4 count target <500 in Karnataka



Punjab

Increased treatment eligibility of CD4 count from the current level of <350 to <500, with 25% expenditure than 2014-15 financial year expenditure allocated optimally shows that condom, and STI program needs to be defunded. While ART program spending will have to increase by 60%, HIV testing will increase by 60%, the spending on OST program will increase by 30%, FSW, MSM and PWID program funding will remain at the current level of the and this will result in 60% reduction in new infections and 66% reduction in deaths by 2017 in comparison to respective values in 2007. This is also estimated to yield a43% reduction in new infections and 47% reduction in deaths by 2030 in comparison to respective values in 2010.

Graph 7.7.2 Number of new infections and deaths in the current scenario and optimized funding scenario with increased CD4 eligibility to <500

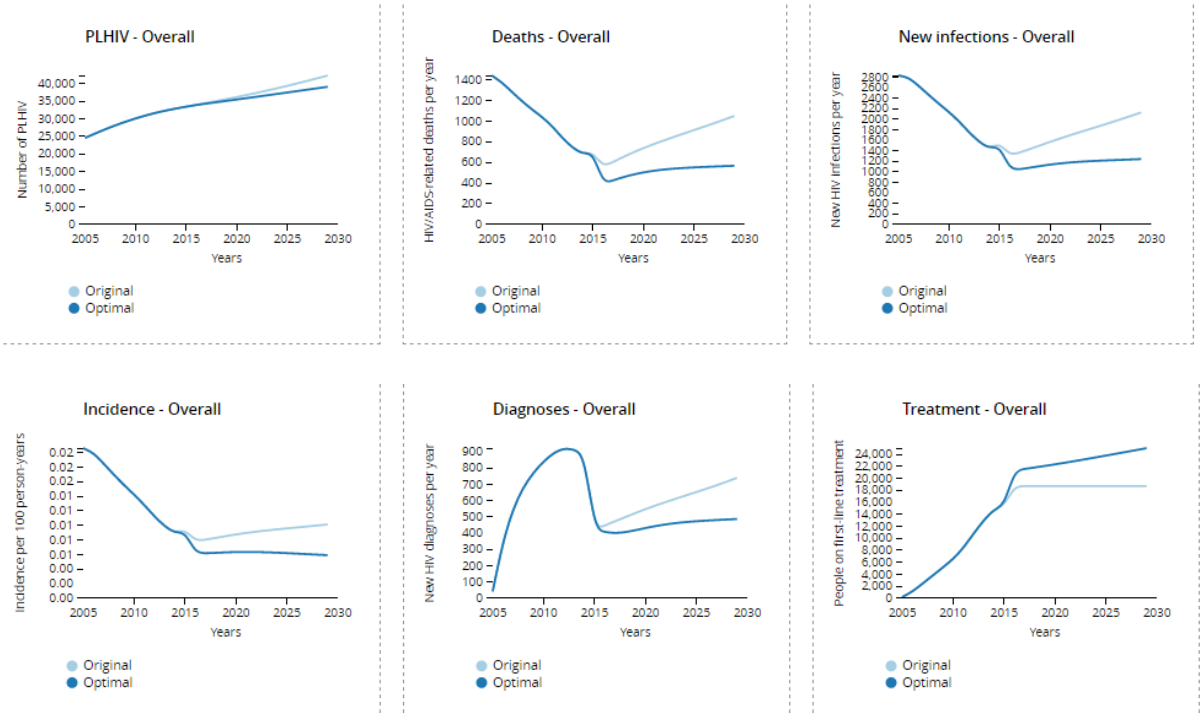
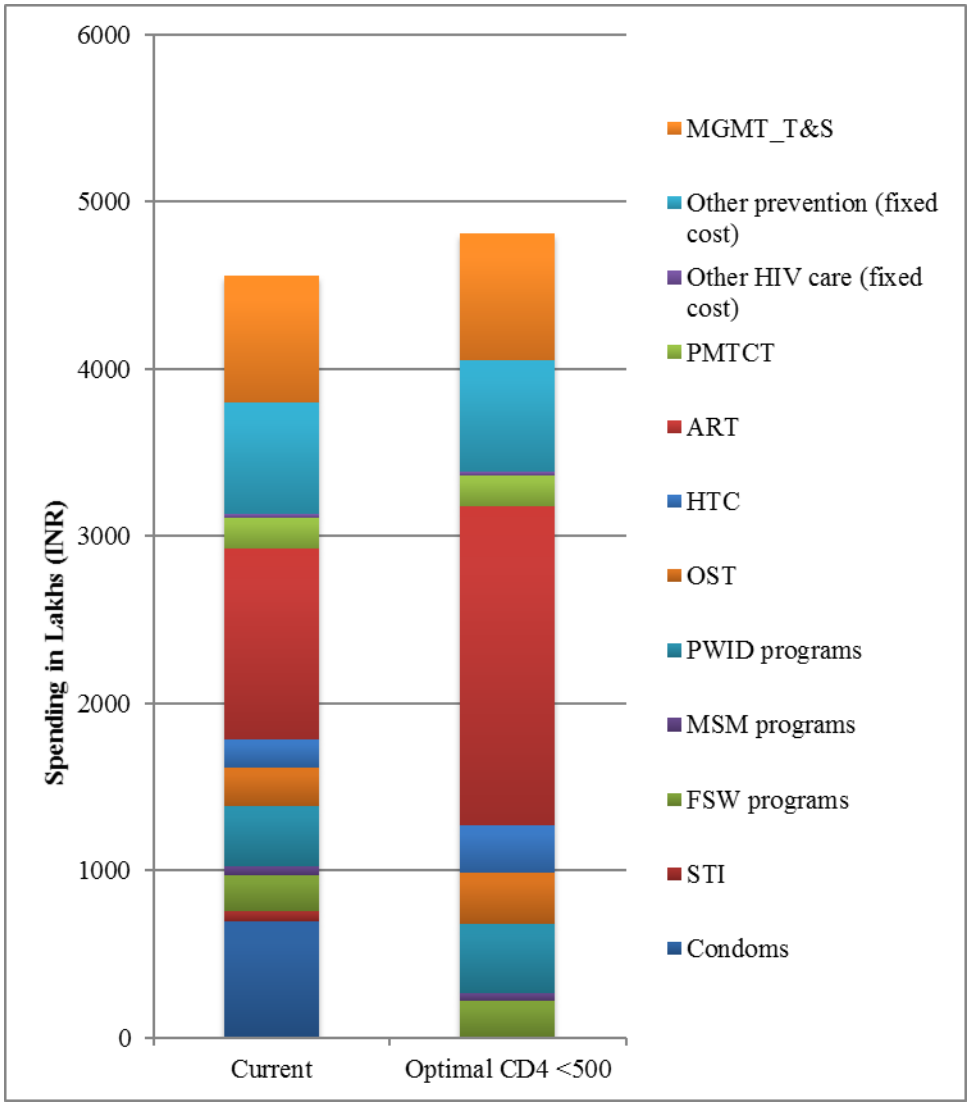


Chart 7.7.2 **Chart 7.7.1 Comparison of current and optimal allocation with 25% more funds with CD4 count target <500 in Punjab**



The optimum allocation of current resources entails a defunding of condom and STI programs and an increased allocation for all other programs.

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Discussions

Epidemic spread and potential

The spread of an HIV epidemic does not solely depend on the natural progression of the disease among different sub populations, but is influenced by risk behaviours, social interactions and risk networks.
The HIV epidemic in Karnataka is primarily driven by sexual transmission routes, exhibits a declining trend and has reached a low level in all sub population groups under consideration. Current trends suggest that the state can achieve the NACP-IV goals but may fall short of SDG targets.
The HIV epidemic in Punjab is driven by sexual and injecting transmission routes, is currently at a low level, while exhibiting a gradually increasing trend among the general population, with a stable-to-declining trend in all high risk population groups. Current trends suggest that the state is unlikely to achieve either NACP-IV goals or SDG targets.
The programmatic response in the country has evolved over the last three decades with recent developments in prevention efforts by introducing new interventions for PWID such as OST and special provisions for female injecting drug users. The effect of these prevention efforts among key populations have practically been demonstrated to effective[31]and reaffirmed through this analysis. However, the projected trends and levels of the epidemic may not change significantly enough to achieve targets set by SDG.

Similarly the key policy decisions on improving the treatment scope which is being rolled out as this report is being prepared needs attention, as they have the potential for influencing the death among PLHIV. These decisions are as follows: (i) All HIV- TB patients are put on ART irrespective of CD4 count. (ii). All HIV positive pregnant mothers are put on Long-term ARV regimen irrespective of CD4 count.(iii) In line with WHO 2013 guidelines, the CD4 count cut-off for initiating on ART has been updated to <500 counts from the earlier <350 count, thus making more people eligible for ART. This has been calculated to be around 80% of all PLHIV. This translates to approximately an additional 12,500 persons in Karnataka and 3,000 persons in Punjab, and 120,000 persons at the national level to be put on ART, from the year 2016.

Funding for HIV interventions

The domestic budget is the major funding source for HIV program funding. Over the period of last five years, there has been substantial decline in the funds contributed from the international donors. However given the changing scenario of source of funds, the Government has improved the TI budget allocation by 25% and the Treatment allocation, to meet the revised ART eligibility. However, it is important to understand increasing funds allocation will fall short of reaching the impact targets unless they done strategically.

In this scenario, the for the program managers and policy makers are four, i.e., (i) reallocate existing funds to saturate more effective interventions thus increasing value for money (ii) work towards better implementation efficiency through reduction of management and institutional overheads, this would result in freeing up additional funds for various programs (iii) increase the budget available for HIV reduction (iv) a combination of all.

Estimates from Optima provide a valuable assessment of the allocative efficiency of current investments in NACP interventions as well as that of a case mix of interventions to meet different program objectives and budget constraints.

Optimum HIV resource allocation for impact and sustainability

ART has proven to be highly effective in terms of HIV burden reduction in all optimisation combinations at the cost of defunding programs such as condom, STI and at times HTC. This raises a question on traditional methods of prevention such as condoms, needle syringe and the emphasis on ART as one that contributes to both prevention and treatment in the context of understanding impact, cost and sustainability in this analysis.

- India has a very large, scaled up and successful prevention programme among KP. The Targeted Interventions have been able to reach out to a high proportion of KP with behavioural change & condom promotion. Repeated behavioural surveys have shown over 90% consistent condom use among KP in certain states. Condoms have been the mainstay of prevention for sexual transmission of HIV that accounts for nearly 90% of all HIV cases in the country, annually. India continues to invest in prevention among KP as one of the primary strategies in future as well.
- Besides the KP intervention, the social marketing strategy for condom promotion has taken the annual off take to nearly 3 billion condom pieces every year in the country. And among the general population, condoms are promoted for triple benefits of family planning, STI prevention & HIV prevention. However, the effectiveness of condom promotion among general population is not as well studied as that of ART. And hence, the model assumptions may also tend to underestimate the prevention impact of condom promotion, especially in general population, where majority of new infections are currently occurring in India.
- There is considerable evidence suggesting behavioural change among people who are HIV positive after being informed of their results following an HIV test, some publications suggest up to 80% consistent condom use[(41)(42)(43)(44)]. Similar evidence is part of Optima's background reference document.
- While calculating the effects of prevention, the information available is the aackground condom use among general population which is around 1.7% in Karnataka and 20% in Punjab (most of the PLHIV in both the states are from general population) and the preventive effect of ART. Thus there is a under representation of effect of condom in prevention
- As focused prevention only tool consistent condom use is as effective as ART or more,[36] at a lower cost. The cost of condom per person per year is around Rs 600 while that of ART is around Rs 6000. The additional benefit of use combined use of ART and condom is documented elsewhere. [37]
- At present the effort to provide condom as per demand is well practiced in key population interventions. Addition of condom services at similar intensity along with ART services, will further add value to the prevention effect at a relatively lower cost. Thus revising the positioning of condom from purely general population intervention to more focused prevention intervention among those who are positive and key population may greatly improve the outcomes.
- In this context, defunding condom programme based on Optima results may be interpreted and applied with caution.

Reducing HIV response costs through more efficient implementation processes and management

The fixed cost expenditure accounts for approximately 25% and 22% of the total HIV expenditure in Punjab and Karnataka respectively. Current analysis shows that improving the efficiency of management processes will allow for additional funds to be redirected towards effective interventions, which in turn help Karnataka achieve SDG targets as well as NACP IV goals. At the same time, such efficiencies will lead to positive gains in terms of program impact by reaching NACP IV goals for Punjab and placing the state in a good position towards the path to reach SDG targets. However, taking advantage of improved institutional and state capacity building investments have been done over the last two to three decades and the opportunity to integrate some of these services to existing health programs at state and national levels may lead to improved outcomes.

Sexually transmitted infection program, condom promotion for general population are also provided by other national programs as part of the general health system intervention. Integration of ICTC, ART and OST with the general health system, to some extent led to improved outcomes in some states. Further inroads into integration may result in higher efficiency gains providing better value for money. During the field work for data collection the team also came across instances of state government putting additional resources for HIV prevention e.g.: State of Karnataka providing funds for reaching out to rural HRG and vulnerable population and the state of Punjab providing OST treatment for PWID etc.

Increasing budget allocation to reach SDG

Existing funds are likely to prove to be insufficient to achieve SDG goals. However, the needs of the two states as indicated by this analysis are quite different. Karnataka would require a 70% increase in budget to meet SDG targets, whereas Punjab would require more than a fivefold increase in current allocation. Given the nature of the epidemic in Karnataka, the optimal resource allocation indicates additional resources for OST, ART and HIV testing, whereas in Punjab the optimal mix indicates additional resources for prevention in key populations, in addition to testing and treatment. These differences arise due to vastly different levels and trends of epidemic, drivers of epidemic and duration of response in each state. Karnataka is known to have a high risk sex practice driven HIV epidemic, with considerable investment from the central government, state government and external donor programs, shows a declining trend. Conversely Punjab, which used to be a low prevalent sexual network driven epidemic, exhibits an increasing prevalence, with the change greatly influenced by the much more recent injecting drug use. Injecting drug use tends to have a rapid increase in HIV prevalence compared to other types of population[38]. In order to address these vastly different HIV epidemics, theresponse needs to be adapted according to different budget requirements which need to be strategically allocated and tailored to handle the epidemic.

Limitations:

Some of the key limitations in preparation of data inputs for the exercise are summarized below.

1. For general population related indicators, the data that is used is predominantly National Family Health Survey (NFHS-3) conducted in 2006. The data being 10 years old is a limitation for the study. However, there is no other general population health and HIV survey conducted after 2006. The latest round of NFHS-4 is underway and results will be available by end of 2016. Where more recent data about general population sourced from other surveys such as condom evaluation surveys is available, it was used.
2. HIV prevalence and other behavioural data for clients of FSW are limited. The only nation-wide representative behavioural survey done among clients of FSW was in BSS 2006[39]. After that, under Avahan IBBA, client survey was done in select districts[40]. In the absence of specific client data, data from behavioural studies among migrants and truckers have been used as a proxy. Under the National AIDS Control Program, migrants and truckers are considered as bridge population and systematic epidemic data is not available for the bridge population.
3. Information on testing and treatment of general population and pregnant women from the private sector is not available with the program. This is a limitation in assessing the actual access to testing and treatment services. In case of pregnant women, the public sector accounts for around 40-50% of antenatal care and institutional deliveries. So, data reported from the program only pertains to those accessing public sector health services[41].Also, it has been assumed that the largest share of the prevention and major share of treatment of HIV lies with the national program.
4. Duplication in numbers of testing and treatment coverage is an issue. There is no clear evidence to assess the extent of duplication. However, a small pilot conducted in the recent past, coupled with programmatic experience, suggests that there may be duplication ranging from 5-20% in testing and treatment coverage, depending on the place and scale up of services.
5. State-wise and risk group-wise data on prevalence of tuberculosis is not available. It is assumed that the rates of TB will not be different across the risk groups.

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Conclusion

Optima, a formal mathematical tool used to model HIV epidemics was used to conduct this analysis and was calibrated to follow trends as in SPECTRUM, which has traditionally been used for HIV estimations in India.

Optima acts as a tool to inform policy makers regarding effective prevention measures which can be taken to reduce the HIV burden. The focus is on PLHIV, to direct prevention efforts, in this instance, placing additional people on ART. This will add value to the HIV reduction efforts and reduce burden on other interventions in both the states of Karnataka (declining epidemic) and Punjab (increasing epidemic) in not only reducing deaths but also reducing new infections.

- With optimal allocation of funds including refining the management/implementation costs, the epidemic can be brought down substantially.
- However, in the state of Punjab: despite optimal allocation of current funds and increased ART program, OST program allocations, we will not be able to meet SDGtargets
- Defunding of general population interventions like condom promotion and STI management is common to both states.
- In view of the priority and resources for prevention among KP under India's AIDS response and condom promotion being the mainstay of KP as well as GP prevention, the recommendation of defunding condom programme in Indian context may be interpreted and applied with caution. OPTIMA does model for condom use among PLHIV, however it does not allow for different behaviour condom behaviour post diagnosis.
- Given the diversity of the HIV epidemic across states and AIDS response being a centrally sponsored programme, it is important that this pilot study be expanded to cover all states of India to enable policy makers at national level to make informed decisions and efficiently manage the programme resources.

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Annex:

Annex-1: Cost- Coverage Data details

Variables	Details of Data	Data Source	Assumptions /Limitations/Challenges
Condom	Coverage: 1.7% adult male using condom- NFHS-3, Karnataka[28]. NFHS-4 Condom- usage: is 1.3%[29] 19.4% of adult male in Punjab are using condom- DLHS-4[30]	Data Source: NFHS-3 for Karnataka DLHS-4 for Punjab Cost data is from Condom Technical Support Group- NACO	Cost: Commodity Cost of Free Condoms + Commodity Cost of Social Marketing Condoms
	Cost: Cost: Commodity Cost of Free Condoms + Commodity Cost of Social Marketing Condoms	Cost data is taken from Condom Technical support Group- NACO	

STI	**Coverage:** Number of STI/RTI Episodes treated at Designated STI & RTI Clinic (DSRC) & Targeted Interventions **Cost :** STI expenditure+ For year 2010-1012: STI drug calculation is average cost per episode* No of episodes. For year 2013-15: STI program expenditure+ STI drugs expenditure	NACO STI Program Reporting through SIMS (Strategic Information Management System) STI cost includes STI program expenditure (variable cost (Kits, Consumables, or reagents, Drugs. Human resource (field workers; personnel at service delivery units) , Training, Set up cost of newly established service delivery centres + drug cost) The drug costs available from the year 2013-14 was used to calculate the unit cost per episode . The same unit cost is used for STI drugs cost for the year 2010-12 which is unit cost* number of episodes	For the year 2010-2012: Karnataka the TI interventions were gradually transitioned to GoI. The numbers provided by NACO captures most of the HRG. But did not capture all that were provided STI/RTI services. The unit costs of both the programs were different. It is important to note that the program supported by AVAHAN is not existing anymore and may not be relevant in the context of future projections including analysis of allocative efficiency thus excluded
FSW	Coverage is actual coverage as per NACO,	Source: TI Program Data sent by NACO	Cost is same from TI – expenditure + variable cost (Training +HR – Dir F) for last three years then used the same logic to work it backword Any caveats: All programs all information is available only for 1 year (14-15) and then applied it to preceding years
MSM	Coverage is actual coverage as per NACO,	Source: TI Program Data sent by , NACO	
PWID	Coverage is actual coverage as per NACO,	Source: TI Program Data sent by NACO	

OST	Coverage: Active client load at OST Centres (S.No. 1.8 of OST reporting format). Cost: OST program expenditure(variable cost) at state + OST medicine expenditure (Drug cost)	OST Program reporting provided by NACO	Added the OST medicines and added to the direct cost of medicines
HTC	Coverage: General clients tested at stand alone & FICTC. Includes both voluntary & referred clients. Cost: ICTC program Expenditure(variable cost) + Cost of HIV Test Kits	Program Reporting through SIMS provided by NACO BSD division Kits are procured centrally and sent ot the states. W took the unit prize of different kits * no of kits. For every positive kit we added 2 and 3 an 10% for wastage. Cost of reference labs not added since very small	In order to create the PMTCT cost, the ICTC program cost has been proportionately divided between general clients & pregnant women. Cost of PMTCT has been deducted from total cost to derive HTC program cost. Cost for kits: Unit price of kit :1stKit Rs 8.1 , 2nd Kit Rs 13, 3rd Kit Rs 17(Ref. Procurement unit cost of kits given by NACO for the year 2013-14) . We assume that the price for kits remains more or less same over the period of time Kit cost calculation: No of tests* Kit 1 unit cost+ No of test positive * Kit 2 unit cost+ No of Test positive* Kit 3 Unit cost+ addition of 10% of tests for each type of kits to calculate for wastage and quality control Costs incurred towards quality control of tests including the cost of SRLs & NRLs, are minimal thus not included in the overall cost.PMTCT drug cost under ART.PMTCT cost deducted and added under PPTCT head Private sector testing information is not available

ART	Coverage – Alive on ART Cost – State Expenditure(variable cost) + (ARV Drugs unit cost) * number on ART + CD4 Kits unit cost* number of kits used	Source: ART Program Data; Procurement Data for Unit costs	Cost of Viral load testing is excluded since it is negligible. This excludes pregnant women on option B. Pregnant women on Option B cost is added in PMTCT. Jump in number of people on ART for some years can be explained by program scale-up by expansion through Link ART and Link ART plus in addition to periodic reduction in CD4 cut-off value for ART initiation. PMTCT drug cost under ART.
PMTCT	Coverage: Number of pregnant women who received B/B+ triple drug regimen Cost: Cost to include cost of HIV tests conducted among pregnant women and no of HIV positive pregnant women receiving ART under option B	Program Reporting from BSD Division Two components – testing component will be picked up and continue to increase. Bu nevirapine not considered, so that cost is not considered. Unit cost of USD 1000 includes triple drug cost. This PMTCT cost is a high cost which is interfering with Cost of testing is 1 usd and ART is 100 usd while PMTCT is USD 1000	Currently, cost in the programis subsumed under ART cost. Coverage by single dose nevirapine not included and nevirapine used to come separately. PMTCT component of ICTC (Pregnant women tested,)+ ART variable unit cost* number of pregnant women on Option B/B+model does not allow nevirapine. In the modelling PMCT like management is fixed cost. Plus no separate resources and
HIV care (fixed cost)	Fixed cost of ART	Fixed cost as defined in previous table	Expenditure sheets.
HIV (prevention fixed cost)	Fixed cost of (STI, TI programs, HTC, PMTCT), and full cost of LWS, IEC and Blood safety	Fixed cost as defined in previous table	No outcome linked to the LWS, IEC and blood safety. Simple expenditure from the states for these items
Management, IS and SIMU	Management cost of (condom, TI programs, HTC, PMTCT)+ IS+ SIMU+ TSU and STRC)		

Variables	**Details of Data**	**Data Source**	**Assumptions /Limitations/Challenges**

Condom	Coverage: 1.7% adult male using condom- NFHS-3, Karnataka[28]. NFHS-4 Condom- usage: is 1.3%[29] 19.4% of adult male in Punjab are using condom- DLHS-4[30]	Data Source: NFHS-3 for Karnataka DLHS-4 for Punjab Cost data is from Condom Technical Support Group- NACO	Cost: Commodity Cost of Free Condoms + Commodity Cost of Social Marketing Condoms
	Cost: Cost: Commodity Cost of Free Condoms + Commodity Cost of Social Marketing Condoms	Cost data is taken from Condom Technical support Group- NACO	
STI	**Coverage:** Number of STI/RTI Episodes treated at Designated STI & RTI Clinic (DSRC) & Targeted Interventions **Cost :** STI expenditure+ For year 2010-1012: STI drug calculation is average cost per episode* No of episodes. For year 2013-15: STI program expenditure+ STI drugs expenditure	NACO STI Program Reporting through SIMS (Strategic Information Management System) STI cost includes STI program expenditure (variable cost+ drug cost) The drug costs available from the year 2013-14 was used to calculate the unit cost per episode . The same unit cost is used for STI drugs cost for the year 2010-12 which is unit cost* number of episodes	For the year 2010-2012: Karnataka the TI interventions were gradually transitioned to GoI. The numbers provided by NACO captures most of the HRG. But did not capture all that were provided STI/RTI services. The unit costs of both the programs were different. It is important to note that the program supported by AVAHAN is not existing anymore and may not be relevant in the context of future projections including analysis of allocative efficiency thus excluded
FSW	Coverage is actual coverage as per NACO,	Source: TI Program Data sent by NACO	
MSM	Coverage is actual coverage as per NACO,	Source: TI Program Data sent by , NACO	
PWID	Coverage is actual coverage as per NACO,	Source: TI Program Data sent by NACO	

OST	Coverage: Active client load at OST Centres (S.No. 1.8 of OST reporting format). Cost: OST program expenditure(variable cost) at state + OST medicine expenditure (Drug cost)	OST Program reporting provided by NACO	
HTC	Coverage: General clients tested at stand-alone & FICTC. Includes both voluntary & referred clients. Cost: ICTC program Expenditure(variable cost) + Cost of HIV Test Kits	Program Reporting through SIMS provided by NACO BSD division	In order to create the PMTCT cost, the ICTC program cost has been proportionately divided between general clients & pregnant women. Cost of PMTCT has been deducted from total cost to derive HTC program cost. Cost for kits: Unit price of kit :1st Kit Rs 8.1 , 2nd Kit Rs 13, 3rd Kit Rs 17(Ref. Procurement unit cost of kits given by NACO for the year 2013-14) . We assume that the price for kits remains more or less same over the period of time Kit cost calculation: No of tests* Kit 1 unit cost+ No of test positive * Kit 2 unit cost+ No of Test positive* Kit 3 Unit cost+ addition of 10% of tests for each type of kits to calculate for wastage and quality control Costs incurred towards quality control of tests including the cost of SRLs & NRLs, are minimal thus not included in the overall cost. Private sector testing information is not available

ART	Coverage – Alive on ART Cost – State Expenditure(variable cost) + (ARV Drugs unit cost) * number on ART + CD4 Kits unit cost* number of kits used	Source: ART Program Data; Procurement Data for Unit costs	Cost of Viral load testing is excluded since it is negligible. This excludes pregnant women on option B. Pregnant women on Option B cost is added in PMTCT. Jump in number of people on ART for some years can be explained by program scale-up by expansion through Link ART and Link ART plus in addition to periodic reduction in CD4 cut-off value for ART initiation
PMTCT	Coverage: Number of pregnant women who received B/B+ triple drug regimen Cost: Cost to include cost of HIV tests conducted among pregnant women and no of HIV positive pregnant women receiving ART under option B	Program Reporting from BSD Division	Cost is subsumed under ART cost. Coverage by single dose nevirapine not included. PMTCT component of ICTC+ ART variable unit cost* number of pregnant women on Option B/B+
HIV care (fixed cost)	Fixed cost of ART	Fixed cost as defined in previous table	
HIV (preventio n fixed cost)	Fixed cost of (STI, TI programs, HTC, PMTCT), and full cost of LWS, IEC and Blood safety	Fixed cost as defined in previous table	
Manage ment, IS and SIMU	Management cost of (condom, TI programs, HTC, PMTCT)+ IS+ SIMU+ TSU and STRC)		

Annex-2: Demography and HIV prevalence

Variables	Details of Data	Data Source	Assumptions /Limitations/ Challenges

FSW	There are two population size for FSW, MSM and IDU as per last discussion. One- taking in to account the numbers already shared i.e actual target for FSW, MSM and IDU as per program in the demography sheet for population size Two- taking into account the estimated number of 2009 as per mapping data and keeping it constant through- out the period for which coverage data is.	**NACO.**	
Clients	5% of adult male population is considered as clients for Karnataka based on condom impact study Punjab NFHS-3 state report Punjab Page-23[31]	Karnataka: Calculations were done on the basis of published paper by Venkatraman et al[32] : calculation is done this model by dividing the estimated total number of client visits to all FSWs in a year, with the average annual Number of visits made per client. (FSW 84494 in year 2013, 76% has regular clients 4 per week and the regular clients is expected to be the same for the year +83% has occasional clients 4 per week which will cumulate for 41 working weeks = 11897687 The frequency and average n of visits by clients per year is based on BSS 2006 which is mean 3.6 visits in last three months or 14.4 visits per year[33]. The estimated no of clients in a year is = 11897687/14.4= 826228. This when rounded off is approximately 5% of adult (15-49 years) population	The population growth will have same trend as general population growth
MSM	There are two population size for FSW, MSM and IDU as per last discussion. One- taking in to account the numbers already shared i.e actual target for FSW, MSM and IDU as per program in the demography sheet for population size Two- taking into account the estimated number of 2009 as per mapping data and keeping it constant through- out the period for which coverage data is.	**NACO**	

PWID	There are two population size for FSW, MSM and IDU as per last discussion. One- taking in to account the numbers already shared i.e actual target for FSW, MSM and IDU as per program in the demography sheet for population size Two- taking into account the estimated number of 2009 as per mapping data and keeping it constant through- out the period for which coverage data is.	**NACO**	
GP Male (15-49 years)	Total General population male of age 15-49 years – (Client) population – MSM - IDU	These are figures based on Demroj population projections and are used by the national government in its process of HIV estimations.	
GP Female (15-49 yrs)	Total General population Female of age 15-49 years	These are figures based on Demproj population projections and are used by the national government in its process of HIV estimations.	
HRG HIV prevalence	Mean HIV prevalence from HIV Sentinel Surveillance (HSS)	All available data from 2005-2011	Invalid sites (sites with less than 75% of sample size) excluded
Clients HIV Prevalence	HIV Prevalence among Truckers from Trucker IBBA is taken as proxy for clients in Punjab. IBBA Clients data for Karnataka	Published study report : Two round of IBBA study publication on Karnataka [34] Assuming that truckers are proxy for clients: Punjab data is calculated from Pandey et al 2008. North-west route: 3.7%[35] .	
GP Male HIV prevalence	HIV sentinel Surveillance prevalence	NACO[36]	
GP Female HIV Prevalence	HIV sentinel Surveillance prevalence	NACO [36]	
Tuberculosis Prevalence	National prevalence of TB has been applied to all groups assuming uniform rates of TB across groups.	2010-2014	WHO estimation

Annex-3: Optional Indicators

Variables	Details of Data	Data Source	Assumptions /Limitations/Challenges

Number of HIV tests per year	Total HIV tests done in ICTC and FICTC	NACO	Reporting is 100%
Number of HIV diagnoses per year	Total HIV test positive at ICTC	NACO	Reporting is 100%
Modeled estimate of new HIV infections per year	Modeled estimates of new HIV infections & HIV prevalence – Spectrum Estimates	NACO[25]	2015 round estimation is provides improved figures than earlier estimations
Modeled estimate of HIV prevalence	Modeled estimates of new HIV infections & HIV prevalence – Spectrum Estimates	NACO[25]	2015 round estimation is provides improved figures than earlier estimations
Number of HIV-related deaths	HIV estimation report 2015, NACO	NACO[25]	
Number of people initiating ART each year	Number of people initiated on ART (Cumulative no of year2- Cumulative no of year-1)	NACO	

Annex-4: Other epidemiology

Variables	**Details of Data**	**Data Source**	**Assumptions /Limitations/Challenges**
Percentage of people who die from non-HIV-related causes per year	Based on sex specific Crude Death Rate (CDR) for each state	Census India[37]	CDR is same across the population sub groups
Prevalence of any ulcerative STIs & Discharging STIs.	HRG – BSS 2006/ GP- BSS 2006 Client- BSS Client- Punjab FSW, Client and MSM from 2007 to 2009 Karnataka is from IBBA related publications	Published data	For 2006:MSM Punjab: Data is from state of UP. As there is no data from Punjab on MSM and UP another north Indian state with similar HIV surveillance figures for MSM of Punjab

Prevalence of any ulcerative STIs & Discharging STIs	HRG - BSS GP- BSS Client- BSS FSW, Client and MSM from 2007 to 2009 Karnataka is from IBBA related publications		
TB Prevalence	As per national prevalence - 2010-2014	WHO estimation	State level and population sub group wise estimation is not available.

Annex-5: Testing and Treatment

Variables	**Details of Data**	**Data Source**	**Assumptions /Limitations/Challenges**
Percentage of population tested for HIV in the last 12 months HRG	TI Program data for HRG.	NACO	
Percentage of population tested for HIV in the last 12 months :Client	Clients: Trucker & Migrant data from TI Program	NACO	Client from routine data : considering Trucker and migrant as clients : Total Migrant and trucker tested in a year / Target No of Trucker + migrants
Percentage of population tested for HIV in the last 12 months - GP	GP – NFHS-3- Table 11.14 volume-1[38]	NFHS-3	
Probability of a person with CD4 <200 being tested per year	No data		
Number of people on first-line treatment	number of PLHIV alive and on First Line ART	NACO	
Number of people on subsequent lines of treatment	Cumulative number of PLHIV alive and on Second Line ART		Not required (UNSW feedback)

Treatment eligibility criterion	As per program	NACO	As government has announced relaxation of CD4 count to 500, it is estimated that in Karnataka there will be additional 13000 and in Punjab there will be 3500 people added to the existing people who are on ART.
Percentage of people covered by pre-exposure prophylaxis	No data		Prep is not a national policy
Number (or percentage) of women on PMTCT (Option B/B+)	Same as coverage data	ART CMIS ,NACO	
Birth rate (births per woman per year)	Calculated from CBR for each state[37]	Census -2011	Birth rate (births per woman per year) – Crude Birth Rate from SRS; Calculation: • (CBR/1000)* Total Population= Total Births Indicator: Total Births/ Total Women
Percentage of HIV-positive women who breastfeed	SIMS data, NACO	Similar levels of breast feeding in NFHS-3	SIMS data to be more close to the real figures as this is a closely monitored program

Annex-7: Sexual Behavior

Variables	Details of Data	Data Source	Assumptions /Limitations/Challenges

Average no of acts HRG	Step-1: Total number of sex acts (A) from program. Step-2: Total number of sex acts from IBBS: example: % of FSW having commercial sex partners * number of commercial sex acts (B) + % of FSW having casual sex partners * number of casual sex acts (C)+ % of FSW having regular sex partners * number of regular sex acts (D)= total number of sex acts (E). Step 3- Calculating distribution: Commercial= B/E Casual= C/E Regular= D/E Step-4: Multiplying the distribution with A gives number of sex acts per FSW/HRG with respect Commercial or Casual or Regular partners Same formula is used to calculate the sex acts of MSM and IDU	NACO Program data and IBBS 2014-15	Per week and per month data for HRG can be extrapolated to per year FSW is active for 41 weeks per year. MSM and IDU active for 12 months
Average no of Acts GP and Client	Two data sources used to arrive at reasonable number of sexual acts per GP. Limited studies are available. Study among GP from Orissa shows average of 7.7 acts per month[39]. And the second study from India which is among women shows that Coital frequency was noted at 4.32 times/month in women ≥35 years but 7.2 times/month in women <35 years.[40]	As clients are subset of GP male, their behaviour with regular partner will remain more or less similar.	Assumption: Clients are sub population of general population thus the number of sexual activity will not be lower than the general population. Client will have more no of sex acts with regular partner > commercial partner t> casual partner.

Percentage of people who used a condom at last act with regular partners	As reported in BSS and IBBA. BSS for HRG, Client and GP, GP data for 2006 is consistent condom use as condom use with regulate partner in last sex is not available in BSS	IBBA and BSS -2006 data published literature	Karnataka: BSS and IBBA data for HRG and Clients will be generalizable to whole state MSM data for Punjab is proxy- actual data is from UP -(BSS 2006 only)
Percentage of people who used a condom at last act with casual partners	As reported in BSS for HRG, Client and GP	IBBA and BSS data published literature	Karnataka: BSS and IBBA data for HRG and Clients will be generalizable to whole state MSM data for Punjab is proxy- actual data is from UP -(BSS 2006)
Percentage of people who used a condom at last act with commercial partners	As reported in BSS and IBBS. BSS for HRG, Client	IBBA and BSS data published literature IBBS data for respective population	Karnataka: BSS and IBBA data for HRG and Clients will be generalizable to whole state MSM data for Punjab is proxy- actual data is from UP-(BSS 2006)

Annex-8: Injecting Behaviour

Variables	**Details of Data**	**Data Source**	**Assumptions /Limitations/Challenges**
Average number of injections per person per year	TI Program data for total injections	NACO	
Average percentage of people who receptively shared a needle/syringe at last injection	BSS 2006 and IBBS 2014-15	NACO	
Number of people who inject drugs who are on opiate substitution therapy	Number of people who have taken OST at least once during the month of March (financial year ending) Source: OST Program Data	NACO	Data is on active people on OST.

Risk-related population transitions (average number of years before movement)	Data the risk related transitions has been defined as 15 years for IDU and 8 years for FSW. MSM is assumed not to transition in lifetime. Data on clients is not available.	Based on BSS-2006. The same numbers are also used for National HIV estimations.	Transitions remain same throughout the analysis period

Annex-9: Constant:

Treatment failure rate:
As discussed with NACO, the program experience reflects 8% per year failure rate on first line ART

Annex- 10: Economics and Costs

Consumer price Index;
https://www.imf.org/external/pubs/ft/weo/2015/02/weodata/index.aspx
Purchasing power parity:
As this is related to rupees , is same for both the states. The data is taken from **source: http://data.worldbank.org/indicator/PA.NUS.PPP**

GDP
State GDP for each state taken separately from Ministry of Statistics and program Implementation Source:
http://mospi.nic.in/Mospi_New/site/inner.aspx?status=3&menu_id=82
Press release and statement Item 13

State Government Revenue
Revenue+ Capital income
Source: State Finances a Study of Budgets, Reserve Bank of India.
https://www.rbi.org.in/scripts/AnnualPublications.aspx?head=State%20Finances%20:%20A%20Study%20of%20Budgets

State expenditure
Revenue+ capita expenditure
Source: State Finances a Study of Budgets, Reserve Bank of India.
https://www.rbi.org.in/scripts/AnnualPublications.aspx?head=State%20Finances%20:%20A%20Study%20of%20Budgets

Total Health Expenditure/ Domestic/ International – as percentage of GDP, WB
Government spending on Health
State expenditure on health taken from national health accounts published documents for the two states . http://www.mohfw.nic.in/showfile.php?lid=3118
2009-2012 are actual expenditures by centre and state
2012-2014 are estimates as published

Annex-11: Manual calibration of parameters

Calibration parameters	Karnataka	Punjab
Mortality | HIV-related mortality rate (AIDS stage)	0.1	0.1
Efficacy | Per-exposure efficacy of medical male circumcision	0.42	0.42
Efficacy | Per-exposure efficacy of condoms	0.05	0.05
Efficacy | Transmission-related behavior change following diagnosis	1	1
Injecting drug use | Reduction in risk-related injecting frequency for people on OST	0.46	0.46
PMTCT | Relative transmission probability under option B/B+	0.1	0.1
Transmission | HIV transmission cofactor increase due to ulcerative STIs	2.65	2.65
Transmission | HIV transmission cofactor decrease due to virally suppressive ART	0.3	0.3
Treatment failure | Failure rate per year for first-line ART	0.1	0.1
Treatment failure | Failure rate per year for subsequent lines of ART	0.16	0.16
Per-exposure HIV transmission probability for injection with a contaminated needle-syringe	0.008	0.008
Per-exposure HIV transmission probability for penile-vaginal insertive intercourse	0.0004	0.0004
Per-exposure HIV transmission probability for penile-vaginal receptive intercourse	0.0008	0.0008
Per-exposure HIV transmission probability for penile-anal insertive intercourse	0.0138	0.0138
Per-exposure HIV transmission probability for penile-anal receptive intercourse	0.0011	0.0011
Relative force-of-infection for FSW	1	3.8
Relative force-of-infection for Clients	2	4
Relative force-of-infection for MSM	0.015	0.28
Relative force-of-infection for PWID	0.02	0.45
Relative force-of-infection for Males 15-49	1.4	3.8
Relative force-of-infection for Females 15-49	0.3	1.2
Inhomogeneity in force-of-infection for FSW	0	0
Inhomogeneity in force-of-infection for Clients	0	0
Inhomogeneity in force-of-infection for MSM	0	0
Inhomogeneity in force-of-infection for PWID	0	0
Inhomogeneity in force-of-infection for Males 15-49	0	0
Inhomogeneity in force-of-infection for Females 15-49	0	0
Initial prevalence for FSW	0.1	0.0115
Initial prevalence for Clients	0.055	0.01
Initial prevalence for MSM	0.09	0.008
Initial prevalence for PWID	0.018	0.12
Initial prevalence for Males 15-49	0.0086	0.0016
Initial prevalence for Females 15-49	0.005	0.00135
Initial population size for FSW	96057	25645
Initial population size for Clients	779366.5	146210.8
Initial population size for MSM	24096	5351
Initial population size for PWID	3107	22961
Initial population size for Males 15-49	14807964	6992669
Initial population size for Females 15-49	14932921	6546854
Overall population initial relative testing rate	1	1
Overall population final relative testing rate	1	1
Year of mid change in overall population testing rate	2012.5	2012.5
Testing rate slope parameter	1	1

Annex 12: Comparison of Optima and Spectrum results for Karnataka and Punjab-

	PLHIV		No of new infections		Deaths	
Karnataka	**Optima**	**Spectrum(Lower-upper bound)**	**Optima**	**Spectrum**	**Optima**	**Spectrum**
2007	238,654	2,44,500(2,11,512-2,83,531)	6929	5815 (4,673-7,194)	14026	18370(13,628-33,453)
2008	229,959	2,34,191(2,03,217-2,71,059)	6458	4950 (3,869-6,231)	13047	16621(11,988-31,304)
2009	221,947	2,25,665(1,95,965-2,60,214)	5831	3860 (2,939-4,995)	11721	13668(10,531-21,509)
2010	214,710	2,18,944 (1,90,447-2,51,859)	5177	3495 (2,610-4,671)	10342	11317 (8,467-19,172)
2011	208,321	2,14,506(1,86,777-2,46,613)	4436	3199(2,337-4,404)	8707	8645(6,403-14,800)
2012	202,924	2,11,519(1,83,838-2,44,156)	3672	2947(2,072-4,187)	7012	6920(4,300-9,876)
2013	198,407	2,06,826(1,79,818-2,40,575)	3075	2715 (1,843-3,934)	5773	5802(4,134-8,007)
2014	194,505	2,02,622(1,75,945-2,35,872)	2602	2565(1,677-3,821)	4795	4972(3,622-6,958)
2015	191,010	1,99,060(1,73,200-2,31,184)	2375	2383(1,529-3,643)	4445	3744(2,416-5,783)
Punjab						
2007	27,038	23258 (17,472-35,714)	2633	2537 (1,553-3,272)	1281	978(661-1,848)
2008	28,158	25036 (18,807-36,873)	2459	2421(1,499-3,133)	1192	756(519-1,426)
2009	29,185	26825 (20,407-38,319)	2292	2301(1,450-2,974)	1111	651(452-1,126)
2010	30,120	28683(22,097-39,973)	2136	2312(1,483-2,987)	1039	609(432-1,072)
2011	30,967	30598(23,855-41,954)	1958	2308(1,518-3,013)	949	558(395-996)
2012	31,718	32488(25,321-43,772)	1745	2319 (1,570-3,053)	834	612(377-908)
2013	32,370	34017(26,838-45,018)	1565	2244(1,557-2,979)	741	601(379-864)
2014	32,941	35495(27,863-46,462)	1438	2169 (1,528-2,874)	679	531(377-741)
2015	33,460	36794(28,954-47,838)	1439	2059(1,471-2,746)	703	523(367-761)

Annex-13: Standard Constraints

Program Name	Not less than	Not more than
FSW	75%	999%
MSM	75%	999%
PWID	75%	999%
OST	100%	999%
ART	100%	999%
PMTCT	100%	999%

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PUBLIC HEALTH FOUNDATION OF INDIA
IN COLLABORATION WITH
NATIONAL AIDS CONTROL ORGANISATION,
NATIONAL INSTITUTE OF MEDICAL STATISTICS,

BURNET INSTITUTE
AND
THE WORLD BANK